Ontario Geological Survey
Report 226

Geology of the

Calm Lake Area

District of Rainy River

by
S.L. Fumerton

1985

Ontario

Ministry of
Natural
Resources

©1985 Government of Ontario

ISSN 0704-2582
ISBN 0-7729-0278-X

Publications of the Ontario Ministry of Natural Resources are available from the following sources. Orders for publications should be accompanied by cheque or money order payable to the *Treasurer of Ontario.*

Reports, maps, and price lists (personal shopping or mail order):
Public Service Centre, Ministry of Natural Resources
Room 1640, Whitney Block, Queen's Park
Toronto, Ontario M7A 1W3

Reports and accompanying maps only (personal shopping):
Ontario Government Bookstore
Main Floor, 880 Bay Street
Toronto, Ontario

Reports and accompanying maps (mail order or telephone orders):
Publications Services Section, Ministry of Government Services
5th Floor, 880 Bay Street
Toronto, Ontario M7A 1N8
Telephone (local calls), 965-6015
Toll-free long distance, 1-800-268-7540
Toll-free from area code 807, 0-ZENITH-67200

Every possible effort is made to ensure the accuracy of the information contained in this report, but the Ministry of Natural Resources does not assume any liability for errors that may occur. Source references are included in the report and users may wish to verify critical information.

Parts of this publication may be quoted if credit is given. It is recommended that reference to this report be made in the following form:

Fumerton, S.L.
1985: Geology of the Calm Lake Area, District of Rainy River; Ontario Geological Survey Report 226, 72p. Accompanied by Map 2467, scale 1:31 680.

1000-85-U of T Press

CONTENTS

Page
Abstract . . . vii
Introduction . . . 1
        Present Geological Survey . . . 1
        Topography and Drainage . . . 1
        Access . . . 2
        Previous Geological Work . . . 2
        Acknowledgments . . . 2
        Terminology . . . 4
General Geology . . . 5
  Early Precambrian . . . 5
    Metavolcanics . . . 5
      Mafic to Intermediate Metavolcanics . . . 7
        Flows . . . 7
        Pyroclastic Rocks . . . 8
        Debris Flows . . . 8
        Amphibolite . . . 9
        Gneissic Metavolcanics . . . 9
        Petrography . . . 10
        Alteration . . . 11
        Petrochemistry . . . 11
      Felsic Metavolcanics . . . 11
        Flows . . . 11
        Pyroclastic Rocks . . . 11
        Petrography . . . 14
    Metasediments . . . 14
      Quetico Metasediments . . . 14
        Wacke and Mudstone . . . 15
        Biotite Gneiss . . . 15
        Correlation . . . 16
      Seine "Series" Metasediments . . . 16
        Polymictic Conglomerate . . . 16
        Sandstone and Mudstone . . . 19
          Arenite and Wacke . . . 19
          Siltstone, Shale, and Slate . . . 19
        Petrography . . . 20
        Correlation . . . 20
      Calm Lake Metasediments . . . 20
        Conglomerate . . . 21
        Arenite and Wacke . . . 22
        Biotite and Hornblende Gneiss . . . 23
        Petrography . . . 24
        Correlation . . . 25
      Chemical Metasediments . . . 25
    Metamorphosed Felsic Intrusive Rocks . . . 26
      Sheets within the Calm Lake Metasediments . . . 27
      Stocks within the Calm Lake Metasediments . . . 27
      Stocks within the Metavolcanics . . . 27
        Petrography . . . 28
      Hillyer Creek Granodiorite Dome . . . 29
      Little Joe Creek Leuco-Tonalite Dome . . . 29
    Metamorphosed Mafic to Intermediate Intrusive Rocks . . . 30
    Felsic to Intermediate Intrusive Rocks . . . 31
      Diorite to Tonalite Stocks . . . 31
      Granite Stocks . . . 32
    Mafic Intrusive Rocks . . . 33

Structural Geology 34
Faults 34
Quetico Fault System 34
Little Turtle Fault System 37
Fault System at Hepburn Bay 38
Folds 38
Synclines 38
Antiforms 38
Structures within the Quetico Subprovince 41
Summary of Tectonic and Stratigraphic Events 41
Discussion of Geophysical Data 43
Aeromagnetic Data 43
Airborne Electromagnetic Data 44
Economic Geology 45
Gold 45
Base Metals 45
Iron 46
Description of Properties 46
Andowan Mines Limited [1946] (1) 46
Brown, R.R., and Associates [1954] (2) 47
Canadian Nickel Co. Ltd. [1976] (3) 47
Clark, R.A. (4) 47
Law Occurrence (5) 47
MacLean, R.J., et al. (Independence Mine) (6) 49
McTavish, K.J. (Mayflower Prospect) (7) 54
Location and Ownership 54
History of Exploration 54
Geology 55
Murray, W.S. (Mills Creek Occurrence) (8) 58
Murray, W.S. (Gehl Lake Occurrence) (9) 58
Rivers, E. (Cedar Lake Prospect) (10) 59
Location and Ownership 59
History of Exploration 59
Geology 61
Shell Canada Resources Ltd. (11, 12) 61
Suggestions for Future Exploration 62
References 63
Index 67

TABLES

1— Table of lithological units for the Calm Lake map-area . . . 6
2— Chemical analyses of metavolcanics . . . 12
3— Chemical analyses of foliated tonalite sheets and stocks . . . 28
4— Trace element analyses of pyritiferous, graphitic metasediments . . . 46
5— Assays of grab samples from trenches on the Law occurrence . . . 49
6— Assays of grab samples from the Independence mine dump . . . 51
7— Assays of grab samples from the Independence adit on the shore of Bennett Lake . . . 53
8— Assays of grab samples from Mills Creek occurrence . . . 58
9— Assays of grab samples from Gehl Lake occurrence . . . 59
10— Assays of chip samples from Cedar Lake prospect . . . 60

FIGURES

1— Key map showing location of the map-area . . . vi
2— Sandstone classification . . . 3
3— Plutonic rock classification . . . 4
4— AFM plot of metavolcanics . . . 13
5— $CaO-MgO-Al_2O_3$ plot of metavolcanics . . . 13
6— Modal compositions of samples from Hillyer Creek Dome, Little Joe Creek Dome, tonalite sheets and stocks, and Calm Lake Stock . . . 26
7— Modal composition of samples from diorite to tonalite stocks . . . 31
8— Previous names and suggested names for faults . . . 34
9— Fault and lineament pattern in the Calm Lake area . . . 36
10— Inferred manner of formation of splay faults . . . 37
11— Position of axial planes of synforms and antiforms . . . 39
12— Speculative position of the sedimentary-volcanic contact prior to the emplacement of the Calm Lake and Niven Creek Stocks . . . 40
13— Geological sketch map of the Law occurrence . . . 48
14— Geological sketch map of the main workings at the Independence mine . . . 50
15— Geological sketch map of the Bennett Lake adit of the Independence mine . . . 52
16— Geological sketch map and drill hole plan of the Mayflower prospect . . . 56

PHOTOGRAPHS

1— Tuff-breccia with large vesicular fragments . . . 8
2— Tuff-breccia with lenticular fragments in schistose matrix . . . 9
3— Thin coalescing conglomerate beds in arenite . . . 17
4— Typical Seine conglomerate . . . 18
5— Detail of deformation within the Seine conglomerate . . . 18
6— Calm Lake conglomerate . . . 21
7— Migmatitic to agmatitic rocks derived from the Calm Lake metasediments . . . 22
8— Metatexite in the Calm Lake metasediments . . . 23

MAP
(back pocket)

Map 2467 (coloured) — Calm Lake, District of Rainy River.
Scale 1:31 680.

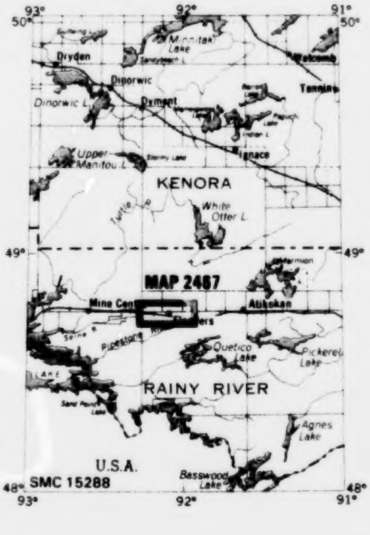

93°
92°
91°
50°
50°
Minnitaki Lake
Dryden
Dinorwic
Dinorwic L.
Dyment
Tanning
Indian L.
Ignace
Upper Manitou L.
Stormy Lake
KENORA
Turtle R.
White Otter L.
49°
49°
Marmion
MAP 2467
Mine Cen
Atikokan
Seine R.
Pipestone
Quetico Lake
Pickerel Lake
LAKE
RAINY RIVER
Sand Point Lake
Agnes Lake
U.S.A.
SMC 15288
Basswood Lake
48°
48°
93°
92°
91°

Figure 1. *Key map showing location of the Calm Lake area.*

ABSTRACT

The Calm Lake area (Figure 1), which includes parts of Bennett, Tanner, and Asmussen Townships, is approximately 25 km east of Mine Centre, and is bounded by Latitudes 48°42′30″ and 48°50′N and by Longitudes 92°00′ and 92°17′W.

The boundary between the Wabigoon and Quetico Subprovinces transects the map-area and is marked by the Quetico Fault for its full length within the map-area. The Quetico Subprovince, which lies south of the fault, consists of a monotonous sequence of steeply dipping intercalated wacke and mudstone with turbidite characteristics. These rocks have consistently north-facing stratigraphic tops. The sedimentary rocks have been metamorphosed to greenschist facies rank near the fault, and to upper greenschist to lower amphibolite facies metamorphic rank with increasing distance from the fault. Metamorphism has obliterated primary structures within the metasediments near the southern boundary of the map-area.

Major faults divide the Wabigoon Subprovince into two structural domains, a small wedge opening to the west, here termed the Seine River wedge, and the main body of the Wabigoon Subprovince. The Seine River wedge is composed of intercalated arenite and boulder conglomerate, which correlate with the Seine "Series", and minor metavolcanics. The rocks in this wedge are folded into an upright isoclinal fold with an axis that plunges at a shallow angle to the west.

The main body of the Wabigoon Subprovince consists of a predominantly mafic metavolcanic sequence which is overlain by a predominantly metasedimentary sequence. The mafic flows are tholeiitic, but of two distinct compositions within the tholeiitic field. Pyroclastic rocks, both felsic and mafic, are calc-alkaline in composition, however, the mafic and intermediate pyroclastic rocks could not always be distinguished from mafic flows where both rock types are extensively altered and metamorphosed. The contact with the overlying metasediments is largely gradational with probable facies changes between intercalated arenaceous metasediments and metavolcanics, but locally the contact is unconformable where conglomerate overlies pillowed flows.

The supracrustal rocks were folded into a possibly inverted sequence prior to the emplacement of two granitoid bodies. Subsequent to the emplacement of these bodies, the whole sequence was refolded during a thermo-tectonic event, which also metamorphosed the rocks to the greenschist facies adjacent to the Quetico Fault and to the amphibolite facies further north. During this metamorphism, migmatite developed and numerous small stocks of tonalite were emplaced. Subsequent to the thermo-tectonic event or during its latter stages, plutonic rocks ranging from gabbro, diorite, and tonalite to granite were emplaced.

Two coeval wrench faults converge within the map-area but the master faults do not merge. The names and correlation of these faults, i.e. Quetico and Little Turtle Faults, have been modified from those previously used.

Two significant types of gold mineralization occur within the map-area. Firstly, gold occurs in metavolcanics and some metasediments associated with extensive shearing and minor development of quartz veins north of Bennett Lake. Secondly, gold mineralization occurs in carbonatized and silicified metavolcanics which mantle small tonalite stocks near Highway 11. Iron mineralization is present only in thin banded magnetite ironstone beds.

CONVERSION FACTORS FOR MEASUREMENTS IN ONTARIO GEOLOGICAL SURVEY PUBLICATIONS

If the reader wishes to convert imperial units to SI (metric) units or SI units to imperial units the following multipliers should be used:

CONVERSION FROM SI TO IMPERIAL			**CONVERSION FROM IMPERIAL TO SI**		
SI Unit	*Multiplied by*	*Gives*	*Imperial Unit*	*Multiplied by*	*Gives*
			LENGTH		
1 mm	0.039 37	inches	1 inch	**25.4**	mm
1 cm	0.393 70	inches	1 inch	**2.54**	cm
1 m	3.280 84	feet	1 foot	**0.304 8**	m
1 m	0.049 709 7	chains	1 chain	20.116 8	m
1 km	0.621 371	miles (statute)	1 mile (statute)	**1.609 344**	km
			AREA		
1 cm²	0.155 0	square inches	1 square inch	**6.451 6**	cm²
1 m²	10.763 9	square feet	1 square foot	**0.092 903 04**	m²
1 km²	0.386 10	square miles	1 square mile	2.589 988	km²
1 ha	2.471 054	acres	1 acre	0.404 685 6	ha
			VOLUME		
1 cm³	0.061 02	cubic inches	1 cubic inch	**16.387 064**	cm³
1 m³	35.314 7	cubic feet	1 cubic foot	0.028 316 85	m³
1 m³	1.308 0	cubic yards	1 cubic yard	0.764 555	m³
			CAPACITY		
1 L	1.759 755	pints	1 pint	0.568 261	L
1 L	0.879 877	quarts	1 quart	1.136 522	L
1 L	0.219 969	gallons	1 gallon	**4.546 090**	L
			MASS		
1 g	0.035 273 96	ounces (avdp)	1 ounce (avdp)	28.349 523	g
1 g	0.032 150 75	ounces (troy)	1 ounce (troy)	**31.103 476 8**	g
1 kg	2.204 62	pounds (avdp)	1 pound (avdp)	**0.453 592 37**	kg
1 kg	0.001 102 3	tons (short)	1 ton (short)	**907.184 74**	kg
1 t	1.102 311	tons (short)	1 ton (short)	**0.907 184 74**	t
1 kg	0.000 984 21	tons (long)	1 ton (long)	**1016.046 908 8**	kg
1 t	0.984 206 5	tons (long)	1 ton (long)	**1.016 046 908 8**	t
			CONCENTRATION		
1 g/t	0.029 166 6	ounce (troy)/ ton (short)	1 ounce (troy)/ ton (short)	34.285 714 2	g/t
1 g/t	0.583 333 33	pennyweights/ ton (short)	1 pennyweight/ ton (short)	1.714 285 7	g/t

OTHER USEFUL CONVERSION FACTORS

1 ounce (troy)/ton (short)	20.0	pennyweights/ton (short)
1 pennyweight/ton (short)	0.05	ounce (troy)/ton (short)

NOTE–Conversion factors which are in bold type are exact. The conversion factors have been taken from or have been derived from factors given in the Metric Practice Guide for the Canadian Mining and Metallurgical Industries published by The Mining Association of Canada in co-operation with the Coal Association of Canada.

Geology of the Calm Lake Area

District of Rainy River

by S.L. Fumerton[1]

INTRODUCTION

The Calm Lake map-area is located about 240 km west of Thunder Bay, and covers about 290 km². It is bounded by Latitudes 48°42′30″ and 48°50′N and Longitudes 92°00′ and 92°17′W.

The east-trending boundary between the Quetico and Wabigoon Subprovinces of the Superior Province transects the map-area. The Quetico Subprovince, in the southern part of the map-area, consists of a monotonous sequence of metamorphosed wacke and mudstone of turbidite association. In the northern part of the map-area, the Wabigoon Subprovince consists of a complex assemblage of metasediments and metavolcanics which have been intruded by granitoid and mafic plutonic rocks. These two subprovinces are separated by a major wrench fault.

The map-area has been prospected primarily for gold, but minor exploration for iron and base metals has also been carried out since the end of last century, with limited success.

PRESENT GEOLOGICAL SURVEY

The geological mapping was done by standard pace-and-compass traverses inland and by shoreline traverses along the shorelines of the Seine River, Calm Lake, and some of the other larger lakes. Air photographs at a scale of 1:15 840 and 1:50 000 were used in the field for topographic control, and the data were transferred to 1:15 840 base maps prepared by the Cartography Section, Surveys and Mapping Branch, Ministry of Natural Resources, from maps of the Forest Resources Inventory.

TOPOGRAPHY AND DRAINAGE

Topography is mostly gently undulating, but on a more local scale, there are some steep-sided hills and shallow gorges, especially where bedrock is exposed. Such small scale topographical features tend to follow weaknesses in the underlying rocks. The Seine River is the main water course and flows from east to west by way of Calm Lake. Elevations over the map-area vary from a maximum of 460 m above sea level near Moonshine Lake and near Warner Lake in the southeast to a minimum of 350 m below the Sturgeon Falls Dam on the Seine River, in the southwest.

Glacial deposits are distributed over most of the map-area but are variable in thickness. In most areas these deposits are primarily restricted to depressions in the bedrock surface. However, thicker though discontinuous deposits trend northwesterly from the former settlement of Flanders, and also occur in the vicinity of Miranda and Niven Creeks, and McPherson and Bennett Lakes.

---

[1] **Geologist, Precambrian Geology Section, Ontario Geological Survey, Toronto.**

Manuscript approved for publication by the Chief Geologist, July 14, 1981. This report is published with the permission of V.G. Milne, Director, Ontario Geological Survey.

CALM LAKE AREA

ACCESS

Highway 11 linking Thunder Bay, Atikokan, and Fort Frances, passes through the southern part of the map-area. In addition, the Seine River and the southern right-of-way of the Canadian National Railway, pass through the map-area. Most of the map-area is easily accessible by motor vehicle along lumber roads which branch off Highway 11, or by boat from the Seine River or Calm Lake. Only the northwest corner is relatively difficult of access. In summer, access to this area is possible only via the Little Turtle River from a point 10 km downstream from the map-area, whereas in winter, a winter-road provides more direct access.

PREVIOUS GEOLOGICAL WORK

The first geological map of the area was by Smith and McInnes (1897), and a description was given by McInnes (1899). These workers attempted to extend to the present area the Keewatin and Coutchiching terminology and stratigraphy which had been developed by Lawson (1889) at Rainy Lake. Since this early work, controversy has existed over the number and stratigraphic position of various metasedimentary units. Many aspects of this controversy are still unresolved. Over the years, considerable work has been carried out in the Rainy Lake region in an attempt to resolve these issues, and in this regard, reference to the Calm Lake area was made by Lawson (1912, 1913), Hawley (1930), and Merritt (1934). Other references to this controversial subject, but in which no specific mention of the Calm Lake area is made, are found in Adams *et al.* (1905), Bruce (1925, 1927), Grout (1925), Tanton (1926), Pettijohn (1937), Poulsen (1979), Poulsen *et al.* (1980) and Wood (1980).

Subsequent to the initial geological survey, parts of the Calm Lake area have been mapped by Young (1960), who covered the northern portion of the area at a scale of 1 inch to ½ mile, and Sage *et al.* (1974) who mapped the northern part of the area at a scale of 1 inch to 2 miles as part of a larger reconnaissance survey. Moore (1940) surveyed the adjoining area to the east, and this same area was remapped by Fumerton (1980). The Calm Lake area is included in geological compilation maps by Tanton (1933) and Davies and Pryslak (1967).

Bow (1899a, b, 1901) gave descriptions of a number of mineral occurrences, and more recently Wilkinson (1980) investigated gold deposits in the area.

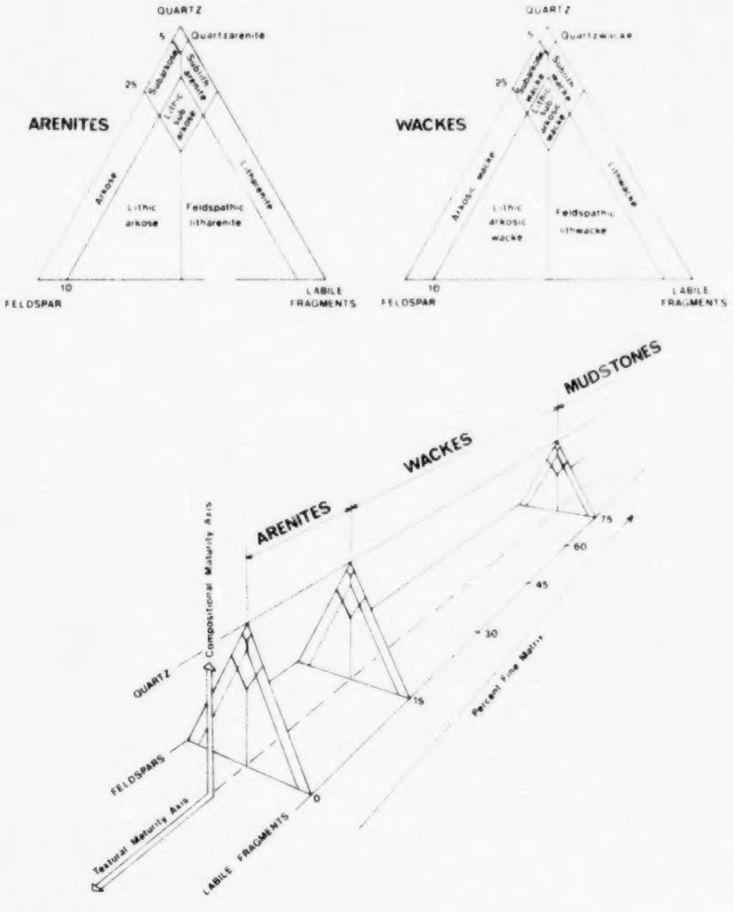
Zoltai (1965) mapped the surficial geology of a large area including Calm lake.

The area was covered by a 1 mile to 1 inch scale aeromagnetic survey (ODM-GSC 1961a,b), a 1:20 000 airborne magnetic and electromagnetic survey (OGS 1980), and a lake sediment survey (OGS-GSC 1980).

ACKNOWLEDGMENTS

The author was ably assisted in the field during the 1980 season by E.L. Bumgarner, A.R. Hill, L. Wu, and P. Hinz.

Thanks are extended to the staff of the Ministry of Natural Resources at Atikokan for their co-operation and assistance during the course of the field season.


ARENITES
QUARTZ
5
Quartzarenite
25
Subarkose
Sublitharenite
Lithic subarkose
Arkose
Lithic arkose
Feldspathic litharenite
Litharenite
10
FELDSPAR
LABILE FRAGMENTS
WACKES
QUARTZ
5
Quartzwacke
25
Subarkose wacke
Sublith wacke
Lithic sub arkosic wacke
Arkosic wacke
Lithic arkosic wacke
Feldspathic lithwacke
Lithwacke
10
FELDSPAR
LABILE FRAGMENTS
MUDSTONES
WACKES
ARENITES
Compositional Maturity Axis
QUARTZ
FELDSPARS
Textural Maturity Axis
LABILE FRAGMENTS
0
15
30
45
60
75
Percent Fine Matrix

SMC 15289

Figure 2. *Classification system used for sandstones in the Calm Lake area (after Young 1967).*

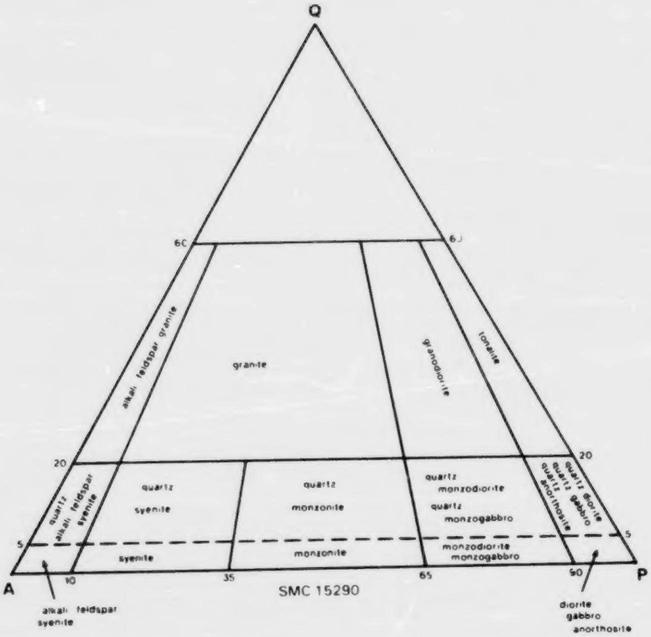

Q
60
60
alkali feldspar granite
granite
granodiorite
tonalite
20
20
quartz alkali feldspar syenite
quartz syenite
quartz monzonite
quartz monzodiorite
quartz monzogabbro
quartz diorite quartz gabbro quartz anorthosite
5
5
syenite
monzonite
monzodiorite monzogabbro
A
10
35
65
90
P
SMC 15290
alkali feldspar syenite
diorite gabbro anorthosite

Figure 3. *Classification system used for plutonic rocks in the Calm Lake area (after Streckeisen 1976).*

TERMINOLOGY

The classification of the metasediments adheres to the system modified by Young (1967) and illustrated in Figure 2. The classification of the plutonic rocks follows the IUGS system (Streckeisen 1976) and is illustrated in Figure 3. Classification of pyroclastic rocks follows the system of Fisher (1966), and the chemical classification of volcanic rocks is that of Irvine and Baragar (1971).

GENERAL GEOLOGY

The map-area is located at the convergence of two major wrench faults, one of which marks the boundary between the Quetico and Wabigoon Subprovinces. The faults essentially divide the area into three structural blocks which are (1) the Quetico Subprovince, (2) the Seine River wedge within the Wabigoon Subprovince, and (3) the Wabigoon Subprovince, exclusive of the Seine River wedge. Within the map-area the boundary between the Wabigoon and Quetico Subprovinces is a narrow zone, typically less than 100 m wide and occupied by lakes or swamps. This zone is for the most part the interface between metavolcanics with stratigraphic tops to the south and metasediments with stratigraphic tops to the north. The pillowed flows and graded beds from which these top determinations were made are progressively obliterated with increase in metamorphic grade north and south of the boundary. This boundary zone separates areas of contrasting structural deformation styles, and is here called the Quetico Fault for reasons that are explained in "Structural Geology".

The Quetico Subprovince within the map-area is composed of a repetitively interlayered sequence of metamorphosed wacke and mudstone that grade into each other. Bedding in these rocks is typically between 2 and 100 cm thick, and preserved primary textures and structures indicate that these rocks form a turbidite sequence with tops to the north.

The Seine River wedge of the Wabigoon Subprovince is dominated by an epiclastic sequence of conglomerate and sandstone termed the *Seine Series* by Lawson (1913). The sequence is crudely stratified, some parts are mostly composed of conglomerate with a few intercalated beds of sandstone, and other parts are mostly composed of sandstone with a few thin beds of conglomerate. A few units of metavolcanics and banded ironstone also occur. The sequence is isoclinally folded about an axis that plunges at a shallow angle to the southwest.

The main part of the Wabigoon Subprovince is a complex assemblage of mafic to felsic metavolcanics, which are intercalated with and largely overlain by sandstone with some interbeds of conglomerate and banded ironstone. These supracrustal rocks have been intruded by mafic to felsic plutonic rocks. A leuco-tonalite body and a granodiorite body intruded the supracrustal rocks prior to the major tectonic-thermal event which affected the Calm Lake area. Abundant tonalite and porphyritic tonalite were emplaced during the tectonic-thermal event as lit-par-lit and stock intrusions. A diorite-tonalite suite, followed by granite, intruded the sequence subsequent to the metamorphism of the area.

The lithologic units for the Calm Lake map-area are listed in Table 1.

Early Precambrian

METAVOLCANICS

For mapping purposes the metavolcanics have been assigned to two main groups, mafic to intermediate, and felsic. The division between these was established primarily on the basis of colour index and the presence of visible quartz in hand-specimen for the felsic group.

The metavolcanics occur in four separate areas that are also characterized by structural and metamorphic differences. The largest occurrence of metavolcanics is an irregular area that trends east and is located north of the Quetico and Little Turtle Faults. In the eastern part of this area the generally east-striking subunits swing to a southeast trend. Primary structures are most common near the Quetico Fault and the stratigraphic units apparently parallel the major east-trending faults in the western part of this area.

TABLE 1. LITHOLOGIC UNITS IN THE CALM LAKE MAP-AREA.

CENOZOIC
QUATERNARY
RECENT
Organic swamp deposits.

PLEISTOCENE
Ground moraine, sand, clay and till.

unconformity

EARLY PRECAMBRIAN
MAFIC INTRUSIVE ROCKS
Diorite

intrusive contact

FELSIC TO INTERMEDIATE INTRUSIVE ROCKS
GRANITE STOCKS (CALM LAKE STOCK)
Fine- to coarse-grained biotite granite, commonly with anhedral feldspar phenocrysts.

DIORITE TO TONALITE STOCKS (NIVEN CREEK AND MIRANDA CREEK STOCKS)
Biotite-hornblende granodiorite, tonalite; hornblende tonalite, diorite, quartz diorite; diorite.

intrusive contact

METAMORPHOSED MAFIC TO INTERMEDIATE INTRUSIVE ROCKS
(MCPHERSON LAKE STOCK)
Gabbro, diorite, amphibolite, quartz diorite, leuco-tonalite.

intrusive contact

METAMORPHOSED FELSIC INTRUSIVE ROCKS
Fine- to coarse-grained biotite tonalite; quartz and feldspar-porphyritic tonalite.

LITTLE JOE CREEK DOME
Foliated muscovite-chlorite leuco-tonalite

HILLYER CREEK DOME
Foliated biotite granite, granodiorite, tonalite

intrusive contact

METASEDIMENTS[a]
CHEMICAL METASEDIMENTS
Chert, iron silicate ironstone, magnetite ironstone, hematite ironstone.

CLASTIC METASEDIMENTS
CALM LAKE METASEDIMENTS
Conglomerate, arenite, wacke, biotite and hornblende gneiss, muscovitic, actinolitic, chloritic, garnetiferous, hornblende-porphyroblastic varieties, metatexite.

SEINE "SERIES" METASEDIMENTS
POLYMICTIC CONGLOMERATE
Clast-supported and matrix-supported conglomerate with pebble to boulder clasts of granitoid and volcanic rocks.

SANDSTONE AND MUDSTONE
Feldspathic and lithic arenite; wacke, siltstone, shale, slate, plagioclase-megacrystic rocks.

QUETICO METASEDIMENTS
Wacke, mudstone; biotite phyllite, schist, gneiss; garnetiferous and amphibolitic varieties.

METAVOLCANICS[a]

FELSIC METAVOLCANICS

Flows, quartz- and feldspar-porphyritic flows; tuff, lapilli-tuff; sericite phyllite; garnetiferous rocks.

MAFIC TO INTERMEDIATE METAVOLCANICS

Coarse- to medium-grained flows[b], pillowed and feldspar porphyritic flows; tuff, lapilli-tuff, tuff-breccia, heterolithic debris flows; chlorite phyllite, schist; amphibolite; hornblende-biotite granoblastic, massive and gneissic rocks; hornblende-porphyroblastic rocks; garnetiferous rocks; carbonatized rocks; feldspar-porphyroblastic rocks; silicified rocks

---

a) Rocks in these groups are subdivided lithologically and order does not imply an age relationship.
b) Some of these may be mafic intrusive rocks.

The second area of metavolcanics lies north of McPherson Lake and Calm Lake. In this area, discrete metavolcanic layers occur as thin lenses of variable size within the dominant metasedimentary host rock. These rocks have been extensively recrystallized to mafic-rich hornblende and/or biotite gneiss, and amphibolite. Because of the absence of recognizable primary structures, the volcanic origin of these rocks is not proven and they may have been derived in whole or in part from mudstone. Also included in this area is a band of metavolcanics which are largely mafic flows. The band forms an east- to north-trending arc north of McPherson Lake.

The third area of metavolcanics lies northeast of Calm Lake. Though this wedge-shaped area of metavolcanics is surrounded by plutonic rocks, its core is occupied by metavolcanics at a relatively low grade of metamorphism. The grade of metamorphism is higher towards the margins where metavolcanics are hornblende gneiss, with and without biotite.

The fourth area of metavolcanics is in the Seine River wedge. Here, the metavolcanics are extensively altered, and contain abundant chlorite and carbonate where they are schistose. However, some pillowed flows can be recognized locally.

Mafic to Intermediate Metavolcanics

The mafic to intermediate metavolcanics were subdivided according to macroscopic fabric. Distinction between mafic and intermediate metavolcanics in the field proved impossible because metamorphism has obscured many of the subtle differences, and consequently these rocks, which cover a large compositional range, were mapped as one unit.

FLOWS

Mafic and intermediate metavolcanic flows form the bulk of the metavolcanics; typically they are fine grained, but aphanitic and coarse-grained (less than 2 mm) varieties are common. Colour varies widely from typically medium olive-green, to dark green, to pale green; weathered surfaces are paler than fresh surfaces. Structural fabric ranges from massive through foliated to schistose, depending on the proximity to shear zones and to hinge zones of folds.

Pillowed flows are common and are usually quite dark in colour and fine grained. In most occurrences, structural deformation has significantly elongated the pillows and obliterated the original zonation within individual pillows. Rarely, amygdules filled with quartz and feldspar occur and were used for top determinations. Feldspar-porphyritic flows are rare but are more abundant than hornblende-porphyritic flows. In both cases the phenocryts are subhedral and less than 1 cm in size, with no preferred alignment.

CALM LAKE AREA

PYROCLASTIC ROCKS

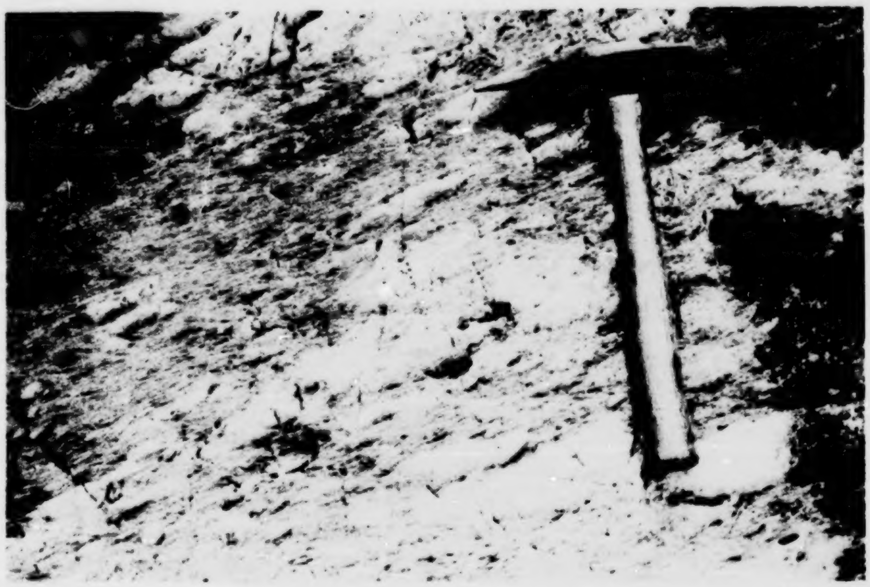
Mafic and intermediate pyroclastic rocks are abundant, but restricted to (1) the main metavolcanic occurrence adjacent to the Quetico and Little Turtle Faults, and (2) the apex of the Seine River wedge. The pyroclastic rocks have been subdivided on the basis of the size of rock fragments into tuff-breccia (larger than 64 mm), lapilli tuff (2-64 mm), and tuff (less than 2 mm). In all cases the matrix is fine-grained and typically has a light green weathered surface and a dark green fresh surface. Fragments are commonly off-white on the weathered surface, medium green on the fresh surface, and more felsic than the matrix. However, rare fragments are darker in colour and presumably more mafic than the matrix. Fragments are usually fine grained and, where the fragments are large, are commonly vesicular (Photo 1). In the vicinity of Bennett Lake some very large fragments up to 2 m in diameter occur, and in the vicinity of the south end of Calm lake fragments up to 0.5 m are common (Photo 2).

OGS 10513

Photo 1. *Tuff-breccia in which large vesicular fragments appear to be more felsic than the matrix. Location: southeast shore of Bennett Lake.*

DEBRIS FLOWS

Heterolithic fragmental rocks are not common in the area and the only known occurrence is at the junction of the power lines near Mills Creek. At this location approximately 20 percent of the rock by volume is made up of angular rock fragments that are randomly oriented and up to 10 cm in size. Most of the fragments are felsic to intermediate volcanic rocks but some are more mafic than the enclosing matrix. Typically the fragments are aphanitic to fine grained, angular, rectangular, and lenticular in shape and usually zoned. This zoning is most pronounced in the felsic fragments and appears to be an alteration phenomena formed at the time of solidification of the matrix. The matrix is fine grained and medium to dark green on both the weathered and fresh surfaces. Because of the fragmental nature of this rock it is thought to be the product of a gas-charged debris flow.



OGS 10514

Photo 2. *Tuff-breccia with lenticular fragments in a schistose matrix. The matrix has been preferentially sheared by a splay fault related to the Quetico Fault. Location: southwest shore of Calm Lake.*

AMPHIBOLITE

Metavolcanic amphibolite is most notable north of Bennett Lake and in the vicinity of Miranda Creek. Commonly these rocks are massive to weakly foliated, medium to coarse grained, and consist of more than 60 percent amphibole and consequently are dark green in colour. In the Miranda Creek area these rocks occupy whole outcrops, but in the Bennett Lake area the amphibolite is interlayered with less altered metavolcanics and metasediments, and is intruded lit-par-lit by granitic dikes.

GNEISSIC METAVOLCANICS

Gneissic rocks derived from metavolcanics are particularly abundant adjacent to the main metavolcanic-metasedimentary contact between Miners and Bennett Lakes, and in the vicinity of Miranda Creek. In addition to these occurrences, gneissic rocks are also common in the metavolcanic bands within the metasediments. The rocks are typically medium grained, vary in colour from medium to dark green, and commonly have a spotted green and white appearance due to the partial segregation of the mafic and felsic minerals. The separation of mafic and felsic minerals into bands is poorly developed where present and rare. Most occurrences have a moderately developed structural foliation but in some locations the rocks are massive. Porphyroblasts of garnet and hornblende occur in some scattered locations within these gneissic rocks. Most porphyroblasts are subhedral to anhedral and are commonly less than 4 mm in size, however, some are up to 20 mm in size.

CALM LAKE AREA

PETROGRAPHY

Examination of the mafic flows in thin section indicates that a wide variety of textures and compositions occur in these rocks. All have been metamorphosed to at least the greenschist facies, and are characterized by the pervasive presence of actinolite, chlorite, and epidote. Relicts of the original mineralogy are locally preserved and indicate that porphyritic feldspar flows were relatively more common than suggested by examination of hand specimen. Quartz content in the thin sections examined ranges between 0 and 20 percent; plagioclase 5 to 60 percent but typically 20 to 60 percent; actinolite 0 to 50 percent; epidote 0 to 40 percent; chlorite 0 to 80 percent; and carbonate 0 to 30 percent. Potassium feldspar, hornblende, biotite, muscovite, sphene, hematite, magnetite, ilmenite, and pyrite occur as accessory minerals.

Quartz, where present, typically occurs in small angular matrix grains (less than 0.2 mm). However, in some thin sections quartz also occurs in recrystallized aggregates that are up to 1 mm in size.

Plagioclase has a bimodal distribution. Subhedral to anhedral phenocrysts between 5 and 0.3 mm in length are common especially in the coarser grained rocks. These are moderately to extensively saussuritized and in some thin sections their grain boundaries merge with the highly recrystallized matrix. Anorthite content of these phenocrysts ranges from An_{27} to An_{55}. The second mode of plagioclase occurrence is slightly altered anhedral grains (less than 0.3 mm) which occur in the matrix. The long axes of these grains are subparallel. Anorthite content of these grains is about An_5.

Where present, actinolite occurs in a variety of forms. In some cases subhedral to anhedral grains (0.2 to 1.0 mm) are randomly oriented and these commonly have mantles of radiating actinolite needles. Augite locally occurs in the core of actinolite grains indicating that actinolite has replaced augite, but elsewhere poikiloblastic grains of actinolite enclose segments of fine-grained matrix which indicates that actinolite was also formed by porphyroblastic growth.

Epidote grains are anhedral (less than 0.5 mm), scattered, and commonly associated with chlorite. Chlorite occurs as subhedral subparallel laths (less than 0.2 mm). In some sections chlorite is concentrated in irregular bands that parallel the mineralogical foliation, in others it occurs as aggregates which pseudomorph an unidentified mineral. However, chlorite most commonly occurs as disseminated grains in the matrix or interstitially to other larger mafic minerals.

Carbonate is an alteration mineral that occurs as disseminated grains or in aggregates which are concentrated in the fine-grained matrix.

Muscovite and biotite, where present, occur in discontinuous trails parallel to the foliation which transects the matrix.

Compositionally the pyroclastic rocks are similar to the flows but have a much more pronounced foliation and more distinct matrix. The grain size of the matrix is typically less than 0.1 mm and consists of abundant epidote, chlorite, and carbonate, in addition to quartz and feldspar. The rock fragments vary from slightly altered to completely carbonatized. In the less altered fragments, primary, randomly oriented feldspar laths can be recognized.

Gneissic rocks and amphibolite have been completely recrystallized under upper amphibolite facies conditions of metamorphism. Hornblende is the dominant mafic mineral and typically occurs as poikiloblastic anhedral grains and as subparallel lenticular grains (less than 2 mm). Mineral cleavages in the poikiloblastic grains are randomly oriented and lenticular grains are commonly deflected around the poikiloblastic grains thus indicating two generations of hornblende. The first grew in a non-differential stress field, the second in a differential stress field. Plagioclase is typified by a high anorthite content (An_{54}) and occurs as irregular interlocking grains which are both twinned and untwinned. Alteration of the plagioclase is commonly slight. Quartz grains are sparsely disseminated in these rocks and typically occur as small rounded inclusions within other grains. Poikiloblastic garnets are rare, but are locally up to 2 cm across, and subhedral in form. Biotite is the minor mafic mineral and where present, is associated with the second generation hornblende grains. Apatite and zircon are common accessory minerals.

ALTERATION

Alteration of mafic to intermediate metavolcanics is common close to shear zones and granitic intrusions. The alteration occurs in two forms: (1) extensive chlorite development, and (2) carbonatization. The degree of alteration is variable from barely detectable to complete replacement by chlorite and/or carbonate. In the first case the end product is green-grey, chlorite schist. In the second case the end product is massive medium-grained carbonate rock with trace amounts of pyrite or limonite and a rusty brown weathered surface.

PETROCHEMISTRY

Ten mafic to intermediate metavolcanic samples and one felsic metavolcanic sample were analysed for major elements and trace elements (Table 2). All these samples exhibited varying degrees of alteration, consequently the analytical data were used to classify the analysed samples according to the method of Irvine and Baragar (1971). The Irvine and Baragar method makes use of the AFM diagram and the plot of normative plagioclase composition versus Al_2O_3 to classify rocks as tholeiitic or calc-alkaline. The mobility of the alkalies and immobility of alumina will bring about differences in classification between the two diagrams in altered rocks. Table 2 is based upon corrected values, whereas the AFM diagram is based on raw data.

All samples are subalkaline and most analyses plot in the tholeiitic field of the AFM diagram (Figure 4). All points contained within the calc-alkaline field on Figure 4 correspond to tuff-breccias or crystal tuffs, and all samples in the tholeiitic field are mafic flows.

Two apparently different compositional ranges occur within the tholeiitic mafic flows (Figure 5). One is characterized by somewhat higher MgO, CaO, Ni, and Cr than the other. Samples from each of these two compositional fields were taken from adjacent outcrops in the Gehl Lake area. The sampled phases are two macroscopically identical coarse-grained flows separated by slate. Therefore it is possible that these compositional differences are a primary phenomena, and not an alteration phenomena.

Felsic Metavolcanics

Felsic metavolcanics form a minor proportion of the metavolcanics in the map-area, and are less texturally variable than the mafic to intermediate metavolcanics.

FLOWS

Only a small number of felsic flows are known within the map-area. These occur primarily at the south end of Calm Lake, and at the outlet of Price Creek. The flows are typically off-white on the weathered surface and pale green, grey or off-white on the fresh surface. The matrix of the rock is aphanitic and contains up to 5 percent subhedral phenocrysts of quartz and feldspar (less than 2 mm). Most commonly the rock is massive but near shear zones the rock is extensively fractured and parts along closely spaced parallel minor shear zones within the rock (1 to 2 cm apart).

PYROCLASTIC ROCKS

Relative to flows, felsic pyroclastic rocks are more abundant and three types have been

TABLE 2. CHEMICAL ANALYSES OF METAVOLCANICS.

Sample	**276b**	**277**	**294**	**274**	**635**	**751**	**785**	**168**	**169**	**841E**	**992C**
SiO_2	50.80	45.60	50.00	50.60	50.20	53.50	53.20	55.10	53.40	51.90	73.40
TiO_2	2.54	1.56	2.27	0.97	1.56	0.74	1.73	0.85	0.96	0.84	0.78
Al_2O_3	13.00	13.60	15.40	15.20	13.00	16.10	15.70	17.40	17.50	15.50	11.90
Fe_2O_3*	18.00	13.30	15.30	11.70	19.10	8.74	10.00	8.05	9.39	12.90	3.66
MnO	0.29	0.21	0.19	0.19	0.36	0.13	0.13	0.11	0.19	0.25	0.07
MgO	1.99	7.28	4.04	6.52	1.48	7.39	5.58	4.96	5.77	3.72	0.85
CaO	5.19	10.60	1.63	8.97	5.70	7.13	6.15	6.60	3.24	6.63	2.12
Na_2	3.93	2.51	5.96	3.45	3.42	2.30	2.01	2.61	5.39	1.94	3.88
K_2O	0.68	0.49	0.57	0.00	0.81	1.05	0.75	0.60	0.33	1.52	1.53
P_2O_5	0.32	0.10	0.27	0.09	0.46	0.15	0.23	0.15	0.17	0.16	0.08
CO_2	2.10	1.90	0.89	0.27	3.05	0.20	0.16	0.47	1.35	2.85	1.01
S	0.01	0.02	0.05	0.02	0.16	0.12	0.08	0.01	0.01	0.29	0.20
TOTAL	98.85	97.17	96.57	97.98	99.30	97.55	95.72	96.91	97.70	98.50	99.48
LOI	3.50	3.70	3.70	2.10	4.40	2.20	3.00	3.40	4.30	4.90	1.20
Ni	<5	138	<5	55	<5	170	94	71	70	46	<5
Cr	<5	114	<5	127	<5	300	147	91	108	31	<5
Cu	8	162	42	80	45	42	45	11	8	72	40
Co	28	52	33	38	23	35	31	24	24	32	5
Zn	165	98	168	93	210	80	104	50	110	141	36
Pb	<10	<10	<10	<10	<10	<10	<10	<10	<10	29	<10

NOTES

Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto. Major elements given in weight percent, trace elements in parts per million.

LOI - Loss on ignition.

Fe_2O_3* - Total Fe expressed as Fe_2O_3.

Chemical classification (see below) is according to the method of Irvine and Baragar (1971) and is based on corrected values.

SAMPLES (Field classification; lithology; chemical classification; location)

276b. Mafic metavolcanic; coarse- to medium-grained flow; tholeiitic andesite; Hwy 11 near Gehl Lake.

277. Mafic metavolcanic; coarse- to medium-grained flow; tholeiitic basalt; Hwy. 11 near Gehl Lake.

294. Mafic metavolcanic; coarse- to medium-grained flow; tholeiitic andesite; Hwy. 11, 2.8 km east of Price Creek.

274. Mafic metavolcanic; flow; tholeiitic basalt; Hwy 11 near Gehl Lake.

635. Mafic metavolcanic; flow; tholeiitic basalt; 200 m south of Hwy 11, 500 m east of Gehl Lake.

751. Mafic metavolcanic; flow; tholeiitic basalt; Seine River, 800 m north of Fin Bay.

785. Mafic metavolcanic; flow; tholeiitic basalt; Seine River, 1200 m north of Fin Bay.

168. Mafic metavolcanic; tuff, tuff-breccia; tholeiitic basalt; west shore of south narrows of Calm Lake.

169. Mafic metavolcanic; tuff, tuff-breccia; tholeiitic andesite; west shore of south narrows of Calm Lake.

841E. Mafic metavolcanic; hornblende-biotite granoblastic gneiss; tholeiitic basalt; north shore of Bennett Lake near Independence adit.

992C. Felsic metavolcanic; tuff, lapilli tuff; calc-alkalic dacite; 1600 m north of east end of Bennett Lake.

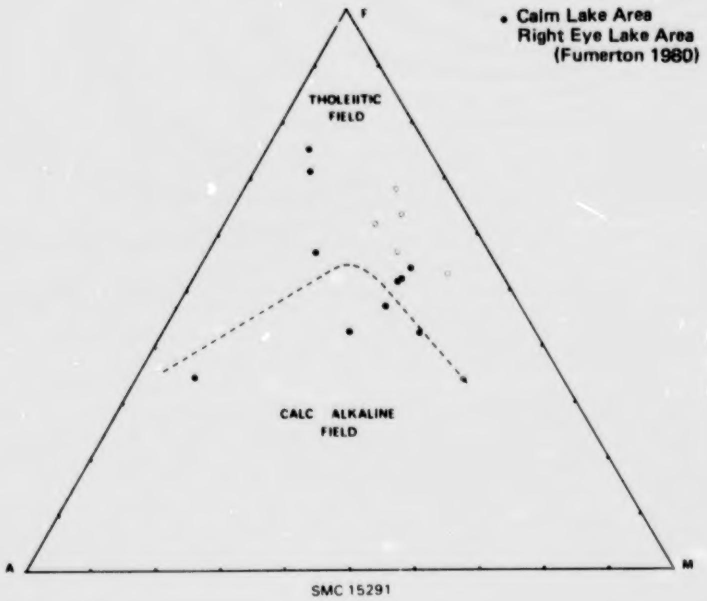


Figure 4. *AFM plot for metavolcanics. The mafic flows are tholeiitic, pyroclastic rocks are calc-alkaline. Samples from Right Eye Lake area (Fumerton 1980) shown for comparison. Dividing line between tholeiitic and calc-alkaline affinities after Irvine and Baragar (1971).*

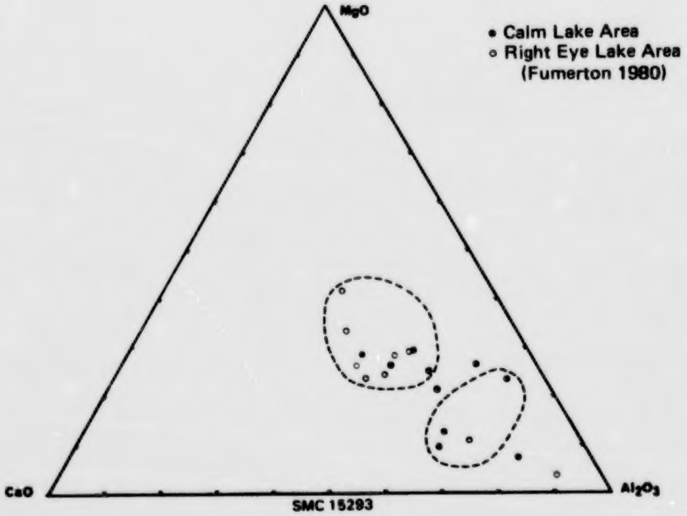


Figure 5. *CaO-MgO-Al_2O_3 plot for metavolcanics from the Calm Lake and Right Eye Lake (Fumerton 1980) areas. Fields enclose all the tholeiitic data, illustrating two distinct compositional ranges. Remaining data points are from the calc-alkaline pyroclastic rocks.*

recognized. Lapilli tuff consists of small (less than 2 cm) lenticular felsic rock fragments sparsely distributed in a weakly foliated matrix. This matrix is commonly off-white on both the weathered and fresh surfaces, and is very fine-grained. The second type, quartz and feldspar crystal tuff, occurs in the vicinity of the Independence mine. These tuffs are composed of less than 10 percent anhedral quartz crystals (less than 2 mm) set in a fine-grained, foliated, off-white matrix. Some of the quartz crystals have a blue tint, and the rock as a whole has similarities to a band of felsic pyroclastic rocks that trends northeast from Modred Lake in the Righteye Lake area (Fumerton 1980). Thirdly, tuffaceous rocks not characterized by crystals or rock fragments are well exposed at the south end of Calm Lake and along the railway tracks north of Mills Creek. However, these two occurrences are locally associated with repetitively intercalated metasiltstone and magnetite beds on a scale of 1 to 10 cm. A gradation exists between the siltstone and the felsic tuff which suggests that these tuffaceous rocks have undergone varying degrees of mechanical sorting and have been mixed with variable amounts of detrital material. All varieties of pyroclastic rocks are off-white on the fresh and weathered surfaces, very fine-grained, and have a foliation that is parallel to bedding where present. Locally a second foliation is also present and this is discordant to the bedding.

PETROGRAPHY

In thin section, matrix material is seen to be composed of very fine quartz, and untwinned feldspar. Within this matrix local patches have recrystallised to a coarser grain size (0.1 mm). This matrix is transected by bifurcating trails of fine muscovite grains (less than 0.1 mm) which are locally associated with carbonate.

The quartz megacrysts (less than 1 mm) have rounded outlines and cataclastically milled margins. The feldspar megacrysts which are all plagioclase, are subhedral to rounded in form, are moderately saussuritized, and have an anorthite content of about An_{25}.

METASEDIMENTS

Metasediments are common in the map-area and have been divided into five units for mapping purposes. Three contrasting clastic sedimentary suites occur in the map-area, isolated from each other either by faults or volcanic strata.

The first suite includes all the metasediments south of the Quetico Fault. This suite is entirely epiclastic within the map-area, comprising medium- to fine-grained sandstone and mudstone, and has been informally termed the Quetico metasediments (Wood 1980). The second suite consists of the sandstone, mudstone, conglomerate and minor ironstone within the Seine River wedge which have collectively been correlated with the Seine "Series" (Lawson 1913). Finally the third suite of metasediments includes the extensive occurrence of sandstone, mudstone, ironstone and minor conglomerate which lies north of the main metavolcanic belt extending from Bennett Lake to Calm Lake, and which is herein informally termed the Calm Lake metasediments.

Quetico Metasediments

Metasediments south of the Quetico Fault and within the Quetico Subprovince are commonly refered to as the Quetico metasediments (Wood 1980), as distinct from the term Coutchiching applied by Lawson (1889, 1913) to metasediments on strike with these, in the Rainy Lake area. The stratigraphic position of these rocks and their correlation with other metasediments termed Coutchiching in the Rainy Lake area has been the focus of considerable controversy. The more general term Quetico metasediments is therefore preferred.

The Quetico metasediments are characteristically monotonous and consist of intercalated wacke and mudstone near the Quetico Fault, and grade into biotite gneiss to the south.

WACKE AND MUDSTONE

The bedded sequence of wacke and mudstone is well preserved in the northern part of the Quetico metasediments. Individual beds within this unit are between 2 and 100 cm thick, although the mudstone beds rarely exceed 5 cm. Commonly individual wacke beds are adjacent to one or more additional wacke beds, and are not consistently separated by mudstone beds. Similarly, a number of individual mudstone beds can be adjacent to each other in the stratigraphic sequence. Grading in individual beds from wacke to mudstone is common and can be used to determine the local stratigraphic tops of the beds. In some instances the 'upper' mudstone contact is not sharply defined, and consequently opposing top directions could be inferred. The top directions recorded on the map were made from outcrops in which no ambiguity existed. This sequence of rocks has turbidite-like characteristics with ABE, BE, and AB Bouma sequences (Walker 1976).

The wacke is light grey on weathered surfaces and darker on fresh surfaces. The rocks are fine to medium grained and inequigranular with 2 to 3 mm quartz, feldspar and rare lithic clasts which form up to 50 percent of the rock. In addition to these, lenses of carbonate up to 3 mm are locally present.

Thin section examination shows that these clasts range from subrounded to angular in form. The quartz grains have been recrystallized internally to subgrains, feldspar clasts are strongly saussuritized, and chert clasts are the only recognizable lithic fragments. The matrix is composed of fine-grained (less than 0.1 mm) quartz, feldspar, epidote, and sphene, with muscovite, biotite, hornblende, chlorite, carbonate, pyrite, and hematite occurring as common accessory minerals. Locally within this matrix, recrystallized, slightly coarser grains of quartz occur in discontinuous trails parallel to the phyllosilicate grains which have a parallel alignment. Milled quartz clasts, pressure shadows next to the larger clasts, and limited fragmentation of these clasts occur near shear zones. In addition to this the carbonate lenses have a preferred optical orientation, and bifurcating tails of muscovite are subparallel to the foliation in the matrix.

The mudstone is medium to dark grey on both the fresh and weathered surfaces, and very fine grained (<< 0.1 mm). Thin section examination shows that the rock is composed of small angular quartz clasts (less than 0.3 mm) disseminated in a matrix which is locally compositionally banded on a millimetre scale. These bands reflect varying abundance of chlorite grains which have a parallel alignment and in turn are parallel to the compositional bands. Minerals recognized in this matrix are quartz, feldspar, and chlorite.

BIOTITE GNEISS

Metamorphic transformation by recrystallization from wacke and mudstone to biotite gneiss increases with distance south of the Quetico Fault, and the distinction between these units is based on the degree of preservation of the primary structures such as bedding. Furthermore, towards the southern boundary of the map-area, quartz-feldspar veins are increasingly common and parallel to the foliation in the host rock. The maximum known thickness of these veins is about 20 cm but typically less than 10 cm.

The gneiss is pale grey in colour with a common though faint rusty tint on both the fresh and weathered surfaces. The rock is fine to medium grained (less than 1 mm) and inequigranular.

Differences between gneiss and wacke include the presence of trace amounts of biotite and the uncommon presence of hornblende and garnet in the gneiss. Garnet, where present, has snowball texture, and grains (less than 2 mm) are commonly fractured. The foliation in the surrounding matrix is deflected around these porphyroblasts. Hornblende grains (less than 1 mm) occur in trace amounts where present and have a subhedral form.

CALM LAKE AREA

The metamorphism of the Quetico metasediments varies from greenschist facies adjacent to the Quetico Fault, where epidote and chlorite are present, to upper greenschist facies about 1.5 km south of the fault, where biotite, garnet, and hornblende are present.

CORRELATION

The relationship of the Quetico metasediments to other supracrustal rocks within the map-area is unknown because of the intervening Quetico Fault. However, some previous workers have correlated these rocks further west with similar metasediments at Rice Bay in the Rainy Lake area, which lies to the north of the Quetico Fault (Lawson 1913; Grout 1925; Merritt 1934; Harris 1974). Mackasey *et al.* (1974) suggested that the Quetico metasediments represent a distal submarine facies of the more proximal metavolcanics and metasediments of the Wabigoon Subprovince. Wood (1980) developed this hypothesis further and suggested that the Quetico metasediments represent a distal turbidite sequence which might correlate with the Seine "Series" to the north of the Quetico Fault.

These hypotheses are not favoured by the author as they require that faulting related to the Quetico Fault was essentially contemporaneous with deposition of the supracrustal rocks in both the Quetico and Wabigoon Subprovinces. The Quetico Fault separates two provinces with significantly different structural styles, unknown lateral displacements, and opposing top directions. Therefore, to have correlative lithologies on opposite sides of the fault is highly improbable if faults post-date sedimentation. Furthermore this faulting would have had to continue through the period of structural and metamorphic deformation without being significantly deformed itself. As discussed below in "Structural Geology", the main displacement along the Quetico Fault was a late stage phenomenon which postdated the formation of major folds in the Wabigoon Subprovince. If faulting did occur during the deposition of the supracrustal rocks in the area, a plausible concept, it would unlikely be related to the Quetico Fault.

Seine "Series" Metasediments

Lawson (1913) informally proposed the term *Seine Series* for the conglomerate and sandstone units which occur along the Seine River. This term is still informally used (Wood 1980), in spite of the incorrect usage of the term *Series*.

These rocks primarily occur in the Seine River wedge, where conglomerate and sandstone units are intercalated on a scale of 10 cm to greater than 200 m. They extend from near Price Lake to beyond Shoal Lake, some 40 km to the west (Davies and Pryslak 1967). Isolated outcrops of conglomerate occur to the east of the Seine River wedge in fault bounded blocks and adjacent to the Quetico Fault. Mudstone and sandstone are intercalated with metavolcanics between Gehl and Calm Lakes, and are tentatively grouped with the Seine "Series" metasediments.

Unlike the monotonous sandstone and mudstone of Quetico metasediments, the Seine "Series" metasediments are characteristically varied, but with no recognized systematic alternation of conglomerate with finer grained metasediments.

POLYMICTIC CONGLOMERATE

Polymictic conglomerate is abundant and is the dominant rock type in a number of bands within the Seine "Series" metasediments. However, Young (1960) considered these rocks to be volcanic tuff-breccia which incorporated some granitic boulders during deposition. Typical conglomerate beds are usually in excess of 1 m thick though in rare occurrences beds consist of a single layer of unstacked pebbles (Photo 3). The clasts in the conglomerate consist of granitic to quartz dioritic intrusive rocks, felsic to mafic metavolcanics, and

OGS 10515

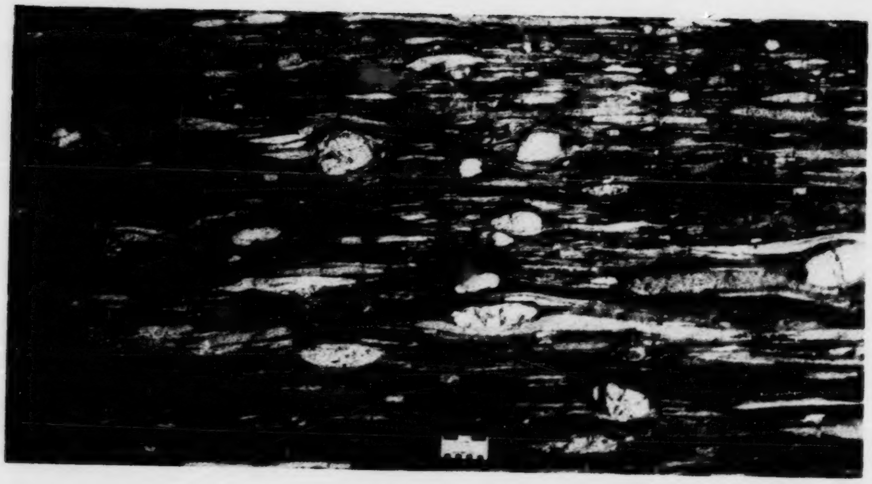
Photo 3. *Thin coalescing conglomerate beds in arenite. The tectonic foliation and direction in which individual clasts have been elongated is perpendicular to the bedding. Location: road cut on Highway 11 east of Price Lake.*

less commonly metasediments (Photos 4 and 5). Granitic, felsic flow, and chert clasts are the most conspicuous clasts because of their colour contrast and resistance to weathering relative to the rest of the rock. However, they are commonly less abundant than intermediate and mafic metavolcanic clasts. The granitic clasts are commonly up to 30 cm in diameter and have a high degree of sphericity, though size and shape are both highly variable over short distances. In contrast, the felsic and chert clasts are relatively much smaller. Most of these clasts are slightly elongated by tectonic deformation subparallel to the bedding plane. The ratio of length to width in horizontal surfaces is usually in the range of 1:1 to 1.5:1, though clasts with a maximum ratio of 5:1 exist. The value of this ratio is strongly dependent on the specific rock type. No vertical faces of the outcrop were found so it is not known if the clasts are prolate or oblate.

Intermediate metavolcanic clasts, felsic tuffaceous or chlorite-rich schistose clasts, and wacke clasts are highly elongated in the horizontal plane (> 5:1), and again the degree of tectonic deformation is dependant upon the rock type of the clast. The original size of these clasts would appear to be smaller than the granitic clasts.

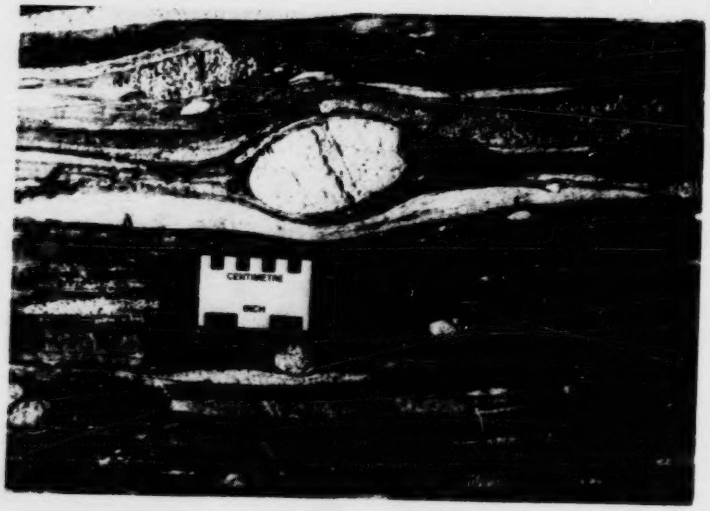
Mafic metavolcanic clasts are common though inconspicuous, because the clasts are highly deformed (>> 20:1) and are easy to mistake for compositional banding in the matrix. In most outcrops individual clasts are in contact with adjacent clasts but in some rare outcrops the clasts are set in a sandy matrix, and constitute less than half of the rock.

Typically the change from conglomerate to an intercalated sandstone bed is abrupt across a bedding plane. However, within the conglomerate, bedding is not discernable and no grading in the clast size is noticeable. The matrix of the conglomerate is commonly medium grained (less than 2 mm), olive green to green-grey, and with noticeable quartz and feldspar on the macroscopic scale.



OGS 10516

Photo 4. *Typical appearance of the Seine conglomerate. Granitoid, felsic metavolcanic, and chert clasts have a high sphericity (1:1 to 1.5:1 length to width). Dioritic and intermediate metavolcanic clasts are elongated (2:1 to 20:1). In contrast, mafic metavolcanic clasts are extremely highly elongated and difficult to recognize (>> 20:1). Location: Sturgeon Falls dam.*



OGS 10517

Photo 5. *Details of the relative degree of deformation within the Seine conglomerate. Granitoid clasts are only marginally elongated and their long axis is commonly oblique to the direction of elongation. These clasts have behaved in a brittle manner and are commonly fractured. Dioritic and intermediate metavolcanic clasts are highly elongated and are commonly impacted by and deflected around more competent clasts. Mafic metavolcanic clasts, which are the most ductile, are extremely elongated and can be mistaken for thin bedding planes. Location: Sturgeon Falls dam.*

No differences in the character of the conglomerate were noticed between the various bands within the Seine River wedge, and within the faulted blocks to the east. The only outcrops of conglomerate with a different character occur along the Quetico Fault near Gehl Lake, and adjacent to the Little Turtle Fault. In these outcrops, the non-granitic clasts have been obliterated by extensive shearing, and the rock consists of granitic clasts set in a schistose matrix which contains abundant chlorite and carbonate.

SANDSTONE AND MUDSTONE

Arenite and Wacke

Arenite and wacke are the dominant rock types in two large bands in the Seine River wedge. Except for a number of intercalated conglomerate beds, the sandstone is uniform over large distances, and changes are apparently non-systematic. Cross-bedding is present in these rocks near the Sturgeon Falls Dam and in a few road cuts along Highway 11 and may be characteristic of this unit.

Sandstone with a high degree of sorting is light green to off-white, and has a grain size of less than 3 mm. Quartz and feldspar are visible on a macroscopic scale and generally form the bulk of the rock with little finer grained matrix. Rarely some granitic and quartz-vein pebbles are scattered through the rock. The predominant rock-types are wacke and feldspathic arenite grading into lithic arenite.

Wacke is olive green to medium grey with a variable but pervasive rusty tint. The weathered surface commonly has a gritty texture or is polished, but some well defined beds have deeply pitted and etched surfaces. The grain size of the quartz and feldspar is commonly in the sand range (less than 3 mm), but some beds are silts (less than 0.5 mm). The interstitial matrix to the quartz and feldspar grains contains abundant chlorite and variable carbonate concentrations. The wacke grades into the arenite.

Macroscopically some of the metamorphosed wacke is similar to the mafic metavolcanics. Consequently the occurrence of wacke within the metavolcanics near the Quetico Fault cannot be accurately delineated.

Siltstone, Shale, and Slate

Siltstone, shale, and slate are not common within the Seine "Series" metasediments. The main outcrops are in a gravel pit south of Highway 11, adjacent to a fault separating the metavolcanics from the metasediments in the Seine River wedge, near the mouth of Mills Creek. Other siltstone and shale units are intercalated with arenite and wacke of the Seine "Series".The occurrences at the gravel pit and near Mills Creek consist of medium-grey shale and siltstone in a turbidite-like sequence, banded on a 5 to 30 cm scale.

These are similar to the Quetico metasediments, but are not characterized by a monotonous stratigraphic sequence. At Mills Creek estuary they are locally intercalated with magnetite beds. A feature of the banded mudstone occurrences near Mills Creek is the high concentration of garnet within the mudstone beds.

Slate is intercalated with metavolcanics near Gehl Lake, and occurs in the strongly deformed rocks near the Mills Creek estuary. Near Gehl Lake, dark charcoal-grey slate occurs in beds up to 3 m thick associated with beds of coarse-grained wacke, and both are interbedded with coarse-grained mafic metavolcanic flows. The slate has a moderately developed cleavage which is parallel to the bedding. The change to wacke is usually abrupt across the bedding plane, but locally a gradation exists which indicates the stratigraphic top direction is towards the south. Sparsely disseminated pyrite grains occur within the slate. East of Gehl Lake this slate unit changes to a predominantly thinly bedded sequence of mudstone.

Thin beds of rock containing plagioclase megacrysts extend between Sturgeon Falls and the mouth of Price Creek. Individual bands do not exceed 3 m in thickness and are of unknown length. Furthermore, contacts with adjacent rocks are indistinct. This rock is distinctive in that it contains up to 30 percent plagioclase megacrysts, which are subhedral in form or fractured, or have a flasered texture. Individual crystals are up to 4 cm in length. The matrix of this rock is indistinguishable from the adjacent wackes.

PETROGRAPHY

Thin sections were examined of wacke and the rock containing the plagioclase megacrysts. These sections show that the wacke has a fine-grained matrix (less than 0.1 mm) primarily consisting of quartz, untwinned feldspar, carbonate and phyllosilicates in variable amounts. The phyllosilicates consist of biotite, muscovite and chlorite, but all three are not always present in every section, and are concentrated in discontinuous trails parallel to the individual grain alignment. Scattered within the matrix are irregular larger grains of quartz and carbonate.

The plagioclase megacrysts where present are highly saussuritized and have an anorthite content of about An_{25}. Most megacrysts are single grains with variable degrees of internal recrystallization and rounding of external boundaries. Some of these megacrysts were probably formed by the coalescing of separate smaller megacrysts. Their origin is unknown.

Minute zoned hornblende occurs in some thin sections. The presence of amphibole and the coexistence of quartz and carbonate indicate that these rocks were metamorphosed at the upper greenschist to lower amphibolite grade.

CORRELATION

The postulated but unproven correlation of the Seine "Series" with the Quetico metasediments has already been discussed.

Two isolated fault-bounded blocks of Seine conglomerate occur to the east of the Seine River wedge. Other fault-bounded occurrences of conglomerate occur adjacent to the Quetico Fault to the east. These are located near or at Gehl Lake within the map-area, and near Banning, Perch and Jackfish Lakes to the east (Moore 1940; Fumerton 1980). In all these locations, the rocks have a schistose matrix enclosing granite pebbles, and are probably fault bounded blocks of Seine conglomerate which have been attenuated by lateral movement along the Quetico Fault.

The correlation of the Seine conglomerate with large occurrences of conglomerate within the Steep Rock "Series" at Atikokan has been suggested but not proven (Hawley 1930; Merritt 1934; Pettijohn 1937; Wood 1980).

In addition to these structurally controlled occurrences, Seine conglomerate is indistinguishable from small occurrences of conglomerate at McPherson Lake and east of Gull Rocks, both within the Calm Lake metasediments. The outcrops at McPherson Lake are located at the contact of the Calm Lake metasediments with the metavolcanics.

Calm Lake Metasediments

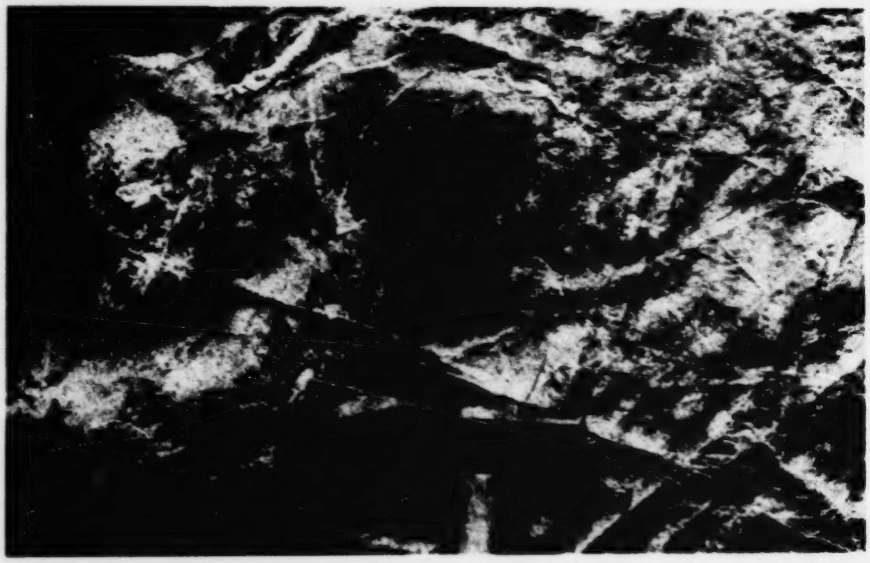
McInnes (1899) originally grouped these rocks with the Coutchiching metasediments, and Young (1960) classified these rocks as biotite gneiss and schist derived from Keewatin metavolcanics. Davies and Pryslak (1967) in their regional compilation grouped these rocks as metasediments. The informal term Calm Lake metasediments is used here for the metasediments located between the metavolcanics and the plutonic rocks in the Wabigoon Subprovince within the map-area.

These rocks primarily occur around the north end of Calm Lake and to the west. Smaller occurrences in the Miranda Creek area separate the Miranda Creek Stock from the metavolcanics to the south. Other occurrences of metasediments occur within the metavolcanics around Bennett Lake and the south end of Calm Lake. Included within this unit are conglomerate, arenite, wacke, biotite and hornblende gneiss, and metatexite. The metamorphic grade increases from south to north concomitant with progressive obliteration of primary structures, anatectic melting, and injection of concordant tonalite dikes.

CONGLOMERATE

Conglomerate was identified in four general areas, (1) at McPherson Lake, (2) along the east shore of the peninsula due east of Gull Rocks, (3) at Hepburn Bay, and (4) along the southern contact of the tonalite stock north of McPherson Lake. In the first area, the conglomerate is indistinguishable on a macroscopic scale from the Seine conglomerate. The conglomerate near Gull Rocks is similar but mafic metavolcanic clasts are dominant. The conglomerate units at Hepburn Bay and north of McPherson Lake are markedly different from the Seine conglomerate, and are difficult to identify because of reaction between clasts and matrix (Photo 6).

In the last two areas, nodular structures interpreted to be pebble remnants comprise about 20 percent of the rock and are compositionally zoned. The most noticable are up to 15 cm in diameter and have cores with high concentrations of hornblende and biotite. Compositionally the cores range from a highly mafic hornblende gneiss to a low-mafic, hornblende and/or biotite gneiss similar to the matrix. The zoning is best developed where large differences exist between the host rock and nodule. This zonation was probably produced during metamorphism of a polymictic conglomerate which has largely obliterated any clasts with a composition similar to the matrix. These conglomerate units also differ from the Seine conglomerate in that there is no evidence of significant tectonic deformation and elongation of the large clasts. Both the relict clasts and the matrix are



OGS 10518

Photo 6. *Calm Lake conglomerate containing network of alteration along narrow veins. Location: southeast shore of Hepburn Bay.*

medium grained (less than 2 mm), and the host rock is off-white, whereas the clasts range from dark-green to off-white.

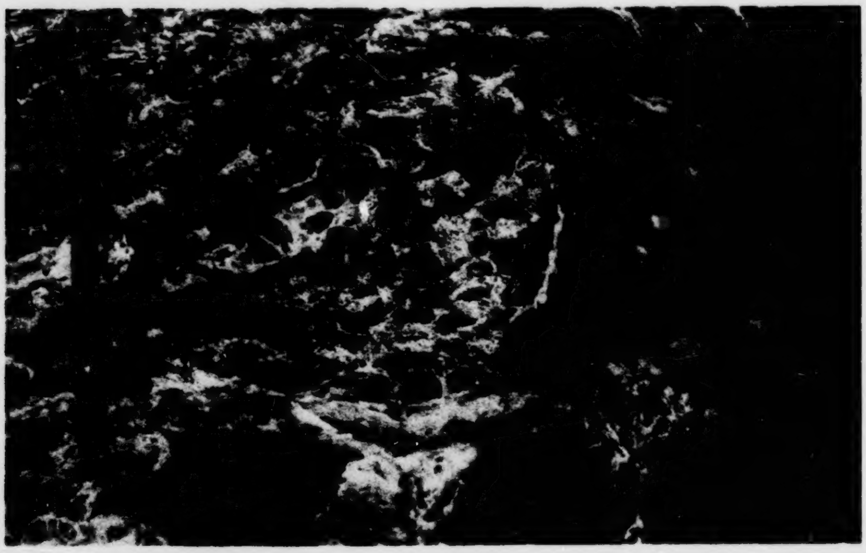
ARENITE AND WACKE

Arenite and wacke are well exposed along the shoreline of Calm Lake around Gull Rocks, in proximity to the main contact with the metavolcanics, and between Calm and Bennett Lakes within the metavolcanics southwest of Blind Pig Bay on Calm Lake. Northwards these rocks progressively give way to gneissic and migmatitic rocks.

Primary structures are rare and consist of bedding and graded bedding. The bedding is best preserved at the south end of Calm Lake where fine-grained sandstone is intercalated with felsic metavolcanics and banded ironstone. Bedding is also well preserved in the sandstone interlaminated with banded ironstone in the vicinity of Gull Rocks. Repetitive graded bedding was only recognized near the Twin Lakes, where the stratigraphic top to the beds faces away from the metavolcanic contact. Most individual beds are between 2 and 20 cm thick, but in some places the beds are up to 2 m thick.

In the vicinity of Indiaonta Lake, the metasediments become progressively darker green concomitant with a change from well sorted arenite to wacke, with decreasing distance from the contact with the metavolcanics. Furthermore, this contact is not distinct, as the distinction between metavolcanics and metasediments is difficult to ascertain.

Wacke is darker in colour than arenite, which is light green to off-white. Wacke ranges from light green to dark olive green, to dark rusty brown and to light brown. The grain size of all these rocks rarely exceeds 1 mm and in many locations is less than 0.5 mm.



OGS 10519

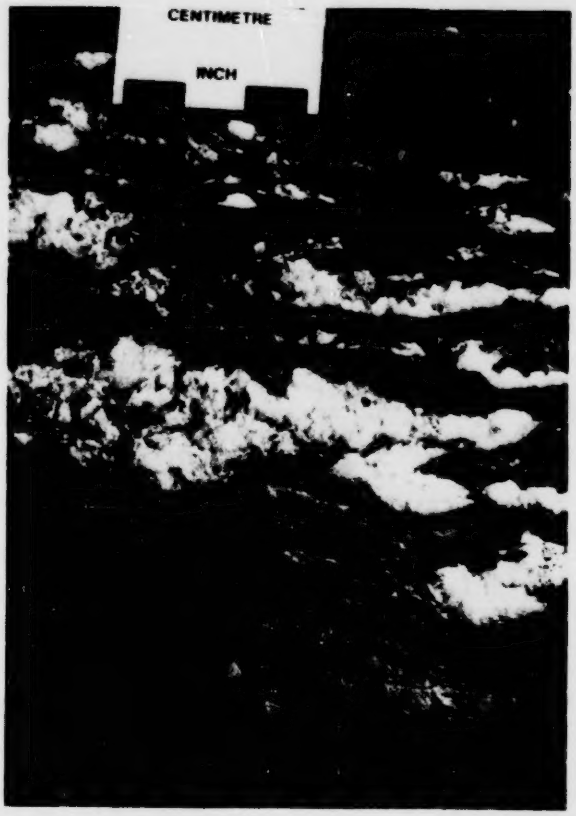
Photo 7. *Brecciated appearance of some anatectically formed migmatitic to agmatitic rocks, derived from the Calm Lake metasediments. Location: northeast shore of Deer Island.*

BIOTITE AND HORNBLENDE GNEISS

Gneissic rocks predominate in the northern and western parts of the Calm Lake metasediments. Generally biotite is the dominant mafic mineral and hornblende either occurs in trace amounts or is absent. Rarely hornblende is the dominant mafic mineral, and in such cases it can be difficult to distinguish the metasediments from mafic metavolcanics.

Grain size is generally less than 1 mm and gneiss that contains biotite varies in colour from light to dark brown with local rusty patches. Hornblende, where present in the rock matrix, imparts a light to dark green colour depending on its concentration. Besides occurring in the matrix, hornblende also forms subhedral porphyroblasts. These are generally sparsely disseminated through the rock and are less than 5 mm in size.

Migmatitic rocks, including brecciated (Photo 7), rafted, veined, layered, and dilation structures, are the product of partial anatectic melting of the metasediments during



OGS 10520

Photo 8. *Metatexite from the Calm Lake metasediments. Quartz-feldspar neosome veins are irregular, but lie subparallel to the foliation in the paleosome, and are mantled by thin biotite-rich neosome rims. Location: east of Mid Island.*

regional metamorphism. Migmatite is well exposed in the Gull Rocks and Hepburn Bay vicinity, commonly with coarse-grained (less than 2 cm) quartz and feldspar segregation veins up to 20 cm thick. The veins are irregular and discontinuous and are parallel to the foliation in the host rock, forming a layered structure or metatexite (Photo 8).

PETROGRAPHY

Microscopic examination of the Calm Lake metasediments shows that they were metamorphosed to the greenschist facies in the south and to amphibolite facies in the north. Furthermore, the rocks metamorphosed to amphibolite grade underwent retrograde metamorphism back to the greenschist facies.

Wacke consists of angular and rounded fragments of quartz, feldspar, and rarely chert set in a fine-grained matrix. The fragments are less than 0.5 mm in size and constitute up to 30 percent of the rock. The matrix consists of very fine grains (<< 0.2 mm) of quartz (30-60 percent), feldspar (20-40 percent), and biotite (5-30 percent) with accessory muscovite, actinolite, epidote, apatite, zircon, hornblende, and opaques. The quartz and feldspar form angular grains, or recrystallized interlocking grains. Biotite, which is the predominant mafic mineral, forms short irregular laths that have a parallel to subparallel alignment, and are partially concentrated into trails (or elipsoidal lenses) parallel to the foliation. Epidote is widely distributed within these rocks, and is associated with the biotite; some grains have allanite cores. Muscovite occurs in some wackes in the northern part of the area, associated with epidote and porphyroblastic plagioclase. The plagioclase porphyroblasts (less than 1 mm) have poikiloblastic margins. Most porphyroblasts have been saussuritized, and the anorthite content where it could be determined is An_{38}. Disseminated actinolite occurs in some wackes in the south but to the north gives way to trace amounts of hornblende. Both minerals are subhedral.

Petrographically the arenite is transitional from the wacke, having less mafic minerals and larger interlocking polygonal grains of quartz and feldspar. Garnet is present in some of the feldspathic arenite as small angular grains or as poikiloblastic grains, commonly mantled by coarse-grained quartz.

The biotite gneiss is gradational into wacke, arenite, and hornblende gneiss. The rock matrix is generally completely recrystallized, with quartz and untwinned feldspar typically occurring as equigranular, interlocking grains (0.1 to 0.7 mm). The feldspar is only slightly saussuritized, and quartz shows limited undulose extinction. Biotite and other mafic minerals are generally of smaller grain size and vary in orientation from random to parallel. Chlorite is common, and is associated with biotite, as an alteration product. Locally it is the dominant mineral, occurring in radiating sheaves, and aggregates intergrown with relicts of biotite in the core of individual grains. North of Gull Rocks, fibrous needles of actinolite commonly occur in irregular lenses parallel to the foliation; in places actinolite forms randomly oriented euhedral prisms within the lenses and in separate aggregates. The actinolite prisms appear to postdate the formation of the actinolite needles which are locally associated with chlorite. In one location south of Gull Rocks, subparallel laths of muscovite occur in a rock containing about 5 percent carbonate. Garnet, though not particularly common, occurs throughout the Calm Lake metasediments, and is relatively more abundant in the vicinity of Gull Rocks and areas to the north and west. The garnet, probably almandine, forms subhedral to poikiloblastic grains, which are commonly mantled by a narrow zone consisting of quartz and feldspar and devoid of mafic minerals. Subhedral or anhedral grains of epidote are ubiquitous in the biotite gneiss and are preferentially associated with the other mafic minerals. On a macroscopic scale, well-defined nodules of fine-grained quartz and feldspar are present in the biotite gneiss but are not common. The nodules, not to be confused with the conglomerate nodules and which were only observed north of Mid Island, are up to 2 by 3 cm in size, and could be metamorphic concretions. However, no metamorphic minerals were observed in these nodules. Sphene, zircon and apatite are minor accessory minerals in the biotite gneiss.

Subhedral, anhedral, and irregular grains of hornblende form up to 30 percent of the hornblende gneiss. The orientation of these grains varies from random to subparallel to each other and biotite grains where present (usually less than 5 percent). Epidote which is particularly abundant in these rocks (up to 15 percent) is closely associated with the hornblende and biotite, and locally is retrograded from hornblende. Hornblende grains commonly contain minute specks of biotite and appear to have replaced biotite grains in a progressive metamorphic reaction. The other minerals in the hornblende gneiss are essentially the same as in the biotite gneiss.

A progressive change from wacke and arenite, through biotite gneiss and migmatite, to hornblende gneiss and biotite gneiss, from south to north, has been documented in the map-area and is well exposed on Calm Lake. This change reflects the progressive increase of metamorphic grade. The change from greenschist to amphibolite facies is marked by the replacement of biotite with hornblende. Retrograde metamorphism has affected those rocks which attained amphibolite grade, and some of the hornblende has been replaced by epidote.

CORRELATION

Top directions and the graded nature of the contact near Indiaonta Lake and McPherson Lake indicate that the Calm Lake metasediments stratigraphically overlie metavolcanics to the south and southwest. Local intercalations of metasediments and metavolcanics which are common at Bennett Lake and at the south end of Calm Lake probably represent a facies change. Such a facies change indicates that the change from deposition of volcanics to the deposition of sediments was in part a lateral change and not entirely a time-stratigraphic phenomenon. However, local unconformable contacts probably exist and coincide with conglomerate occurrences along the contact, as at McPherson Lake and east of Gull Rocks. The Calm Lake metasediments are mainly composed of metamorphosed sandstone with minor intercalated mudstone and conglomerate and a few interbanded metavolcanic layers.

The similarity of the Seine conglomerate to the less altered conglomerates within the Calm Lake metasediments suggests that these two units might be correlatives. This correlation is supported by the occurrence of banded magnetite ironstone in both the Seine "Series" metasediments and the Calm Lake metasediments. However, faulting separates the Seine "Series" metasediments from other nearby metasedimentary units and prevents direct correlation. If this correlation is valid, then because of only minor amounts of conglomerate, the Calm Lake metasediments would represent a more distal facies compared to the Seine "Series" as it occurs in the map-area.

Chemical Metasediments

Within the map-area are a number of units of banded ironstone[1] and one occurrence of chert. The chert is located north of the mouth of Mills Creek and is intercalated with banded ironstone. Banded ironstone occurs primarily within the Calm Lake metasediments, in the vicinity of Calm Lake as disjointed layers, and to the north of McPherson Lake as two separate folded layers which are poorly exposed. Smaller occurrences are scattered between Calm Lake and the Seine River and are associated with epiclastic metasediments that are intercalated with the metavolcanics. Finally, several layers occur within the Seine "Series" metasediments south of the mouth of Mills Creek.

---

[1] Ironstone is loosely defined as a chemical sedimentary rock with more than 30 percent iron-rich minerals (grunerite, hematite, magnetite, or pyrite). These rocks locally grade into magnetitic chert.

The chert is finely laminated (less than 5 mm thick), cyclically interbedded with magnetite ironstone, and is dull olive green to grey on fresh surfaces. Microscopically, the rock is composed of recrystallized polygonal quartz grains less than 0.1 mm in diameter. Fractures within the rock are filled with chlorite, carbonate, and locally quartz.

The principal iron-rich mineral in the banded ironstone is magnetite; iron silicates are common accessories. Hematite is rare and possibly replaces original sulphides in banded ironstone on the Cedar Lake prospect north of Bennett Lake, where it is more common. Typically the individual ironstone layers are 1 to 5 cm thick and are intercalated with fine-grained sandstone layers of about the same thickness. Ironstone occurs in sets of numerous thin beds or less commonly one or two thick beds (less than 1 m). Commonly, magnetite occurs in very high concentrations (70 percent or more) as fine grains (less than 1 mm), however, in the thicker beds magnetite may constitute as little as 10 percent of the rocks with the remainder being composed of quartz, actinolite, grunerite and lesser amounts of biotite, epidote, and rarely garnet. Such rocks are better termed magnetitic cherts. Where hematite occurs, it forms layers (less than 10 cm thick) composed of coarse intergrown blades intermixed with fine-grained massive hematite. These layers have irregular cavities and are intercalated with layers, less than 10 cm thick, of fine-grained quartz which probably are recrystallized chert beds.

METAMORPHOSED FELSIC INTRUSIVE ROCKS

Two granitoid bodies which lie at the north edge of the map-area are parts of larger igneous structural domes, which extend considerable distances to the north and west (Schwerdtner *et al.* 1979). The contacts and foliation in the adjacent supracrustal rocks are for the most part concordant to the margins of the domes, and the foliation within the domes is defined by lenticular quartz lenses. The quartz lenses, and elongate xenoliths, indicate that the domes were affected in a solid state by the last major tectonism which

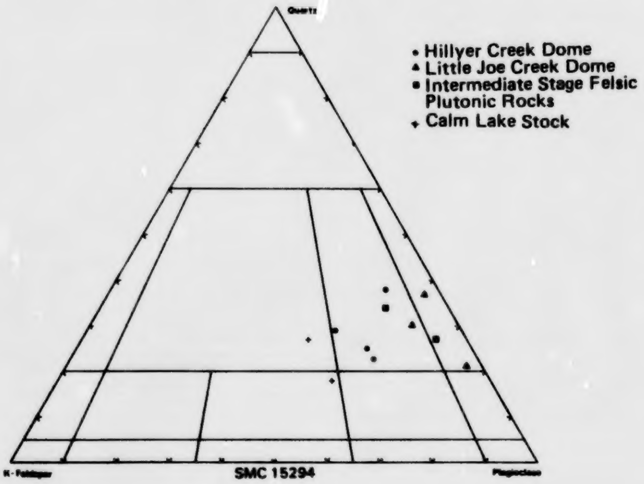


Figure 6. *Point counted modal composition of selected plutonic rocks from the Calm Lake area. Names for fields are given in Figure 3.*

also affected the supracrustal rocks. The northwestern dome is the Hillyer Creek Dome and consists of granite to tonalite (Figure 6). The northeastern dome has been named the Little Joe Creek Dome and consists of leuco-tonalite (Figure 6).

In addition to the domical bodies there are, within the migmatized biotite and hornblende gneiss of the Calm Lake metasediments and the mafic metavolcanics near the Quetico Fault, numerous concordant sheets and irregular stocks of tonalite. The generally concordant mode of occurrence of these bodies suggests that they were emplaced during a period of tectonism that affected the supracrustal rocks and therefore may be younger than the Hillyer Creek and Little Joe Creek Domes.

Sheets within the Calm Lake Metasediments

Intrusive sheets are particularly abundant in a broad band which extends northwest from Gull Rocks, and in a broad zone within the metasediments adjacent to the Hillyer Creek Dome.

Typically these rocks are off-white to pale green and are aphanitic to fine-grained. The rocks consist of anhedral feldspar phenocrysts (less than 3 mm) and subhedral quartz phenocrysts (less than 2 mm), together with small garnet grains (less than 1 mm) disseminated through the rock, though locally the garnet is concentrated into trails. Commonly the rocks in the intrusive sheets are massive, but in places tectonic foliation and quartz lenses less than 1 cm thick parallel the contacts of the sheets. Individual sheets are more than 0.5 m thick, but occur in sets that are pervasive within the metasediments and commonly dominate large outcrops. Parallel to the foliation in these sheets, small quartz veins (less than 2 cm thick) are common and may be boudinaged.

Stocks within the Calm Lake Metasediments

Stocks within the Calm Lake metasediments are located (1) west of Hepburn Bay, (2) north of McPherson Lake, and (3) at the Calm Lake dam. The largest is the stock west of Hepburn Bay, but it is largely overlain by swamps and poorly exposed. The contacts with the adjacent metasediments are gradational and marked by a progressive increase in the abundance and size of tonalite sheets towards the stock. However, partially assimilated relicts of metasediments occur even in the centre of the stock, so that this stock is interpreted as a centre of hypabyssal tonalite sheeting rather than a discrete plutonic stock.

The stock north of McPherson Lake has a well defined southern contact, but a less well defined northern contact. The stock is elongated parallel to the foliation in the metasediments, and truncates the banded ironstone units in this area. The stock is different texturally from the lit-par-lit dikes that occur in the metasediments. The rock is off-white to light pink, and medium to coarse grained (1-3 mm). The stock is weakly foliated at the margins but is massive in the centre.

The stock at the Calm Lake dam is well exposed. It is pale red, medium grained, and massive to weakly foliated. This rock is very similar macroscopically to the post-tectonic Calm Lake granite stock, but stained samples show that it is a leuco-tonalite. Away from the dam the rock is locally off-white and strongly foliated. A number of small mafic dikes cut the stock near the dam, and some of these dikes are very similar macroscopically to the mafic rocks in the McPherson Lake mafic stock.

Stocks within the Mafic Metavolcanics

Within the metavolcanics the tonalite stocks are small. The tonalite consists of fine-grained, off-white matrix containing some small phenocrysts of quartz and feldspar (less than 5 mm). Typically the rock is massive, though locally it is brecciated. The voids in the brecciated rock are filled with rusty carbonate, and the rock is cut by a network of small quartz veins. Around these stocks, the metavolcanics are extensively carbonatized but silicification of the metavolcanics is restricted to narrow uncommon bands within the carbonatized phases.

PETROGRAPHY

Examination of thin sections shows that the tonalite of the sheets and stocks within the metavolcanics and Calm Lake metasediments consists of quartz and microcline phenocrysts set in a completely recrystallized matrix. The quartz phenocrysts have also recrystallized internally whereas the microcline phenocrysts which are perthitic have only recrystallized along internal fractures.

The rock is composed of 20-35 percent quartz, 50-60 percent plagioclase, and less than 10 percent microcline. Muscovite, biotite, epidote, garnet, and hornblende are common accessory minerals occuring in concentrations less than 5 percent, whereas allanite, opaques, carbonate, sphene, green spinel and apatite are less common.

Quartz, besides forming phenocrysts, occurs in the matrix as polygonal and irregular grains (<< 0.1 mm) which are locally concentrated into parallel lenses and trails. Plagioclase typically occurs as polygonal untwinned grains (less than 0.1 mm) in the matrix, but locally some irregular twinned grains and poikiloblastic porphyroblasts occur. These twinned and poikiloblastic grains are moderately saussuritized, and locally antiperthite occurs in the twinned grains. The anorthite content of the plagioclase is low, approximately An_8 in the twinned grains and less than An_{20} in the polygonized grains. This low anorthite content is substantiated by the low calcium in the major element analyses (Table 3). Microcline, where present, occurs as irregular grains associated with the twinned plagioclase, and as phenocrysts. However, stained hand specimens indicate that potassic feldspar commonly does not occur in this rock.

TABLE 3. CHEMICAL ANALYSES OF FOLIATED TONALITE SHEETS AND STOCKS.

Sample	638	841C	841G
SiO_2	69.2	73.4	74.9
TiO_2	0.39	0.19	0.32
Al_2O_3	17.40	14.50	14.00
$Fe_2O_3^*$	2.00	1.48	1.46
MnO	0.04	0.05	0.03
MgO	0.31	0.44	0.37
CaO	0.20	1.01	0.17
Na_2O	9.23	2.69	3.00
K_2O	0.05	3.92	4.61
P_2O_5	0.06	0.04	0.07
CO_2	0.27	0.83	0.18
S	0.01	0.70	0.37
TOTAL	99.16	99.25	99.48
LOI	0.60	2.10	0.90

NOTES

Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto. Major elements given in weight percent.
LOI - Loss on ignition.
$Fe_2O_3^*$ - Total Fe expressed as Fe_2O_3.

SAMPLES (Field classification; lithology; location)

638. Metamorphosed felsic intrusive rock; brecciated stock of medium- to coarse-grained biotite tonalite; 500 m west of Gehl Lake, 400 m south of Hwy 11.

841C,G. Metamorphosed felsic intrusive rock; concordant sheared sheet of porphyritic tonalite within metasedimentary-metavolcanic sequence; north shore of Bennett Lake near Independence adit.

Except for the opaque minerals, the accessory minerals are scattered anhedral grains within the matrix. The opaque minerals form aggregates and trails, as well as disseminations in the matrix.

Hillyer Creek Granodiorite Dome

The Hillyer Creek Dome occupies the core of an arcuate structure in the adjacent supracrustal rocks. Schwerdtner *et al.* (1979) named this body after a creek northwest of the present map-area. Young (1960) designated rocks in this dome and in the Little Joe Creek Dome as intrusive orthogneiss. Potassic feldspar content, as determined by standard sodium cobaltinitrite staining of hand specimens indicates that this dome is compositionally zoned. The core is granitic to granodioritic whereas the margins are tonalitic to quartz dioritic. The foliation is weakly to moderately developed in a nonsystematic manner within the dome. However, a notable exception to this is in the protuberance at the east end of the dome, where the rock is massive and might represent a remobilized phase of the dome.

On the megascopic scale the granodiorite and tonalite in this body are coarse grained (less than 5 mm) and pink to grey on the weathered surface. Locally potassic feldspar megacrysts which might be autometasomatic porphyroblasts are present and are up to 2 cm in size. Parallel and subparallel to the foliation are quartz and quartz-feldspar veins. These veins are up to 15 cm thick and the grains within the veins are up to 15 mm across. Rarely the rock is cut by granitic dikes which parallel the foliation where present, and locally xenoliths occur near the margins.

The foliation in the dome proved difficult to measure and the values plotted on the map could have significant errors. Two or more foliations may be present, one concordant to the strong lineaments which are visible on the aerial photographs and are concordant to the dome's contact, and one parallel to the axial plane of the anticline in the northwest corner of the map-area.

Thin section examination shows that the rocks contain 15 to 35 percent quartz, 40 to 50 percent plagioclase, 3 to 30 percent microcline, less than 10 percent biotite, and less than 2 percent epidote. Muscovite is an accessory mineral that is locally present in trace amounts. Quartz and feldspar are distinctly inequigranular (0.1 to 2 mm) and have interlocking boundaries, or occur as small rounded grains. Local aggregates of quartz occur in parallel lenses, which define a tectonic foliation. Plagioclase (An_{25-28}) is variably saussuritized, and locally antiperthite or myrmekite occurs. Biotite occurs in small, irregular, randomly oriented grains, which in some thin sections have darker margins. Granular epidote is spatially associated with the biotite. Muscovite where present occurs in irregular, randomly oriented aggregates.

Little Joe Creek Leuco-Tonalite Dome

The Little Joe Creek Dome underlies part of the map-area along its northern boundary, extends to the north an unknown distance, and is contained within the Dovetail Lake Dome of Schwerdtner *et al.* (1979).

The leuco-tonalitic rocks of the dome are white on weathered surfaces and pale green to off-white on fresh surfaces. The rocks are weakly to moderately foliated, and lineation varies from nonexistent to strongly developed. Rocks of the dome are coarse grained (less than 4 mm) and locally contain conspicuous parallel lenticular aggregates of quartz that define the foliation and lineation.

Towards the margins of the dome, a gneissic texture is locally present in which the leuco-tonalite of the core is interlayered with quartz diorite units more than 10 cm thick. Elongated xenoliths of hornblende gneiss occur in these gneisses.

Thin section examination shows rocks of the dome to consist of 20-30 percent quartz, 60-75 percent plagioclase, 3-10 percent microcline, up to 5 percent muscovite, and accessory chlorite, epidote, apatite, and biotite.

Three samples illustrate a restricted compositional range mostly within the tonalite field, determined by point counting of thin sections (see Figure 6). Visual estimates made from numerous stained hand samples concur with this. Quartz and feldspar are inequigranular and range in size from 0.1 mm to 2 mm. Quartz is polygonal and concentrated into lenticular aggregates of irregular interlocking grains. Plagioclase is typically irregular in form, and highly saussuritized. Locally zoned porphyroblasts (An_{27} to An_{20}) are less saussuritized. Microcline occurs as irregular grains interstitial to the coarser plagioclase grains. Muscovite occurs as disseminated subparallel grains that are locally concentrated into discontinuous trails, and as aggregates of randomly orientated anhedral laths. Biotite and chlorite are also anhedral and tend to occur in association with the muscovite, as does epidote where present.

This unit has similarities in terms of colour, mineralogy and composition to another leuco-tonalite body about 15 km to the east, at Ear Lake (Fumerton 1980).

METAMORPHOSED MAFIC TO INTERMEDIATE INTRUSIVE ROCKS

Centred on McPherson Lake is a slightly lenticular mafic stock, here named the McPherson Lake Stock, which contains a number of different rock types. Rare, angular, and banded xenoliths (less than 0.1 m thick), consisting of amphibolite and gabbro, are the oldest rocks in the suite. Younger rocks form the bulk of the exposed stock and consist of diorite and quartz diorite. Older, darker diorite forms xenoliths (less than 2 m) in younger, lighter diorites. Quartz diorite primarily occurs as small dikes (less than 1 m thick), and tonalite occurs as small and large dikes. As an entity, the stock appears to form a differentiated suite ranging in composition from gabbro to tonalite, and containing some small metasedimentary xenoliths.

Macroscopically the rocks are massive and range in colour from dark green, or green-grey, though medium grey to off-white, depending on the mafic content of the rocks, and hence their composition. The more mafic rocks are coarser grained than the more felsic rocks (less than 4 mm compared to less than 1 mm) and have a rougher weathered surface.

Thin section examination of the diorite and quartz diorite phases shows that these rocks have been extensively altered and that the alteration primarily affected the mafic minerals. Augite (less than 15 percent) and plagioclase (10-40 percent) occur as relicts of the original mineralogy, whereas actinolite/hornblende (20-70 percent), biotite (10-20 percent), secondary plagioclase and microcline (0-30 percent), epidote (0-5 percent), carbonate (less than 1 percent), muscovite (less than 3 percent), and quartz (0-10 percent) occur as recrystallized grains or alteration products. Opaques, sphene, and apatite also occur in accessory amounts. The augite where present commonly occurs as scattered fragments in the cores of large amphibole grains. In all cases the augite is altered, contains minute unidentified grains within its cleavage planes, and is closely associated with amphibole and biotite. The original plagioclase grains are anhedral, lack twinning and are highly saussuritized. The recrystallized plagioclase is only slightly saussuritized, if at all, and forms large poikiloblastic grains which locally are repetitively zoned from An_{27} to An_{13}, or forms small interstitial grains. Biotite is associated with the other mafic minerals. It occurs in three different modes: (1) anhedral, randomly orientated laths, (2) scattered fragments in optical continuity within amphibole grains, and (3) poikiloblastic grains enclosing amphibole amongst other minerals. Biotite is typically brown but locally is green. Hornblende and actinolite occur in euhedral to anhedral grains, depending on the degree of alteration of amphibole to biotite, and may also contain some augite relicts. Microcline is rarely present, but where it occurs, it forms poikiloblastic grains, and is apparently unaltered. Quartz, where present, occurs as small grains which are typically interstitial to the other more abundant minerals. Epidote, carbonate, muscovite and the accessory minerals have a similar mode of occurrence.

A number of small dikes, located up to 3 km from the stock are similar in composition and texture to the mafic rocks in the main stock and are probably related.

FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

Three major stocks, centred upon Calm Lake, Niven Creek, and the northeast corner of the map-area, and a number of smaller stocks are massive and appear to truncate regional folds in the supracrustal rocks (see Figure 11). Hence, these rocks are interpreted to have been emplaced subsequent to the last major period of folding. Two units occur in this group, the more abundant diorite to tonalite suite of the Niven Creek and Miranda Creek Stocks, and the granite suite of the Calm Lake Stock.

Diorite to Tonalite Stocks

The two main stocks of diorite to tonalite composition are the Niven Creek Stock which is entirely contained within the map-area, and the Miranda Creek Stock which extends to the north and east (see Figure 11). Other smaller stocks and bodies are intrusive into (1) metavolcanics along the lower reaches of Miranda Creek and on the west shore of Calm Lake, and probably form part of the Niven Creek Stock, (2) the metasediments on the west shore of Hepburn Bay, and (3) along the southeastern contact of the Little Joe Creek Dome. Contacts with adjacent country rocks are generally sharp and xenoliths within the contact zone are rare. The Niven Creek Stock is in turn intruded by the Calm Lake granite, and the Miranda Creek Stock is intruded by small granite dikes within the map-area, and by some larger granite stocks to the east (Fumerton 1980).

There is a continuous gradation between diorite, quartz diorite, and tonalite in these bodies (Figure 7). Generally there is no sharp contact between rocks of different composition within the suite but there is an overall progressive change from diorite to tonalite with

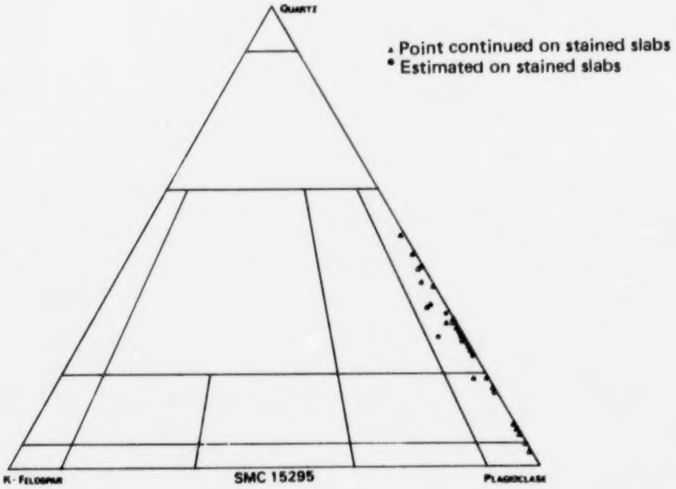


Figure 7. *Modal compositions of the felsic to intermediate intrusive rocks, diorite-tonalite stocks, from the Calm Lake Area. Names for fields are given in Figure 3.*

increasing distance from the contact. Typically the rocks of the suite are coarse to medium grained and mixed off-white and green in colour. The ratio of these colours varies with the composition of the suite: diorite is dark green and particularly abundant in the Niven Creek Stock, and tonalite is light green. Locally the tonalite is fine grained (less than 1 mm) with sparsely scattered feldspar megacrysts (less than 5 mm).

Thin section examination shows that rocks in this unit contain 0-25 percent quartz, 50-70 percent plagioclase, 0-30 percent amphibole (hornblende, actinolite, and cummingtonite), and 0-15 percent augite. Microcline, epidote, carbonate, chlorite, and biotite are alteration minerals which occur in small amounts (less than 10 percent), whereas apatite and sphene are accessory minerals which only occur in trace amounts. Quartz, where present, occurs as interstitial grains (less than 0.1 mm) or in aggregates of interlocking grains. Subhedral grains of plagioclase are variably saussuritized. The saussuritization is intense where the polysynthetic twinning is largely obscured, and slight in poikiloblastic grains, which have inclusions consisting primarily of minute epidote and muscovite grains in aggregates. These poikiloblastic grains have probably recrystallized. The anorthite content of the plagioclase is variable between An_{40} and An_{25}. Amphibole occurs as subhedral grains which are locally poikiloblastic. Hornblende is the most common amphibole, but locally actinolite and cummingtonite occur and may have hornblende mantles with intergrowths of quartz and actinolite in the cores. Locally associated with actinolite are some augite grains which are subhedral. The augite is always mantled by actinolite, but locally the augite is altered to actinolite in the core of the grains. Epidote is scattered throughout the rocks in recrystallized grains which are associated with the other mafic minerals. Biotite, where present, is extensively altered to chlorite which is a common alteration mineral associated with hornblende, augite, and epidote.

Granite Stocks

The principal granite stock in the map-area is the Calm Lake Stock, which is centred on the southern part of Calm Lake. The contact of this stock with the Niven Creek Stock is sharp. Similar granite intrudes metavolcanics at Banning Narrows, metasediments at Hepburn Bay, and Hillyer Creek Dome and Miranda Creek Stock as small stocks and dikes.

The granite is homogeneous, with a slight variation in grain size, and locally contains feldspar megacrysts. Finer grained varieties are more common towards the margins of the stock, whereas the megacryst-bearing variety is particularly common near the centre of the stock.

Macroscopically, the granite is massive and off-white to pink on weathered and fresh surfaces. The rock is generally coarse grained (2-4 mm) and locally contains 15-20 percent potassic feldspar megacrysts. The megacrysts are anhedral, randomly oriented, and less than 1 cm in size. In some locations biotite gneiss xenoliths occur and are less than 5 cm in size.

Examination of thin sections shows that the rock is composed of 16-30 percent quartz, 20-30 percent potassic feldspar, 40-50 percent plagioclase, and less than 10 percent biotite (see Figure 6). Accessory minerals present in trace amounts include sphene, apatite, hornblende and opaques. Epidote is an alteration mineral, also present in trace amounts. Quartz forms large irregular grains which have undergone internal recrystallization. Both twinned and untwinned potassic feldspars occur; grains with "scotch plaid" twinning are more abundant. Blocky perthite and rarely, granophyric textures are also present. Potassic feldspar has been slightly to moderately altered to muscovite, but this alteration is less developed than that which has affected plagioclase. Potassic feldspar grains have an irregular interlocking form, but locally have a euhedral internal zoning. Plagioclase grains are also irregular and interlocking, and contain a subhedral zonation defined by variable degrees of alteration. Locally, small (less than 1.0

mm) subhedral grains of plagioclase do occur. The anorthite content of the plagioclase is approximately An_{20}. Biotite occurs in irregular grains which are locally clustered together and are extensively altered to chlorite and epidote.

MAFIC INTRUSIVE ROCKS

A number of small diorite dikes were observed within the metasediments and plutonic rocks. However these are typically small (less than 2 m thick) and very poorly exposed. The dikes are medium green-grey, massive, medium grained, and contain chlorite, amphibole, biotite, and feldspar. No thin sections were examined.

STRUCTURAL GEOLOGY

The structural fabric within the Quetico Subprovince differs from that in the Wabigoon Subprovince, which in turn differs from that in the Seine River wedge. These differences are primarily in the style of folds within the three different blocks that were placed in juxtaposition by later faulting.

Faults

Three fault systems have been recognized in the map-area: (1) Quetico fault system, (2) Little Turtle fault system, and (3) a system at Hepburn Bay. The Quetico and Little Turtle Fault systems (Figure 8) trend towards an intersection within the map-area but no "master" faults merge. Prior to the present survey, a number of workers had interpreted the merger of these two master faults (e.g. Davies and Pryslak 1967).

QUETICO FAULT SYSTEM

A fault separating metavolcanics to the north from metasediments to the south was recognized by Hawley (1930) in the Right Eye Lake area and the Atikokan area. Merritt (1934) traced this fault from the Atikokan area westwards to the settlement of Flanders within the Calm Lake area.

The term *Quetico Fault* was initially used by Parkinson (1962) for a regional lineament coincident with the faulting documented by Hawley (1930) and Merritt (1934). This lineament was recognized on aerial photographs to extend from 100 km east of Atikokan

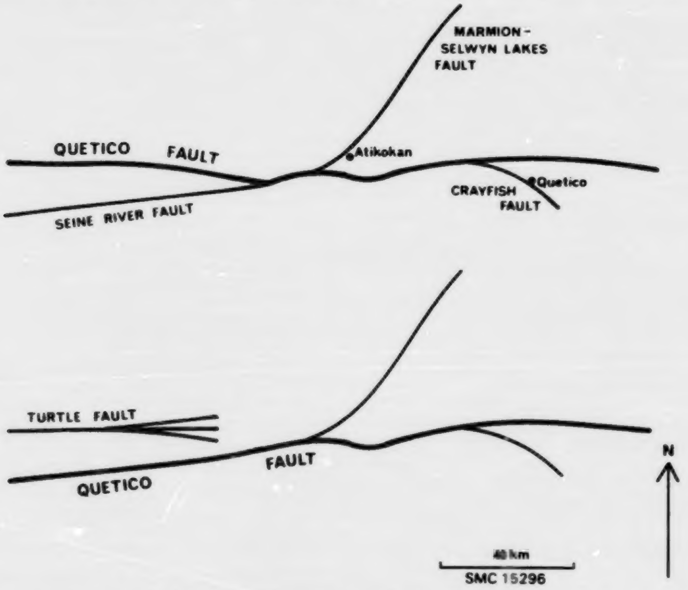


Figure 8. *Names and correlation of major faults in the vicinity of the map-area as suggested by previous workers (top diagram) (Schwerdtner et al. 1979; Wood 1980), and by the author (bottom diagram).*

to 150 km west of Atikokan. The name was apparently derived from the settlement of Quetico on the Canadian National Railway. The western extension of the 'main' lineament was interpreted to follow the Little Turtle Fault system as defined here (Figure 8).

Subsequently, the term Quetico Fault was applied by Kaye (1967) to the eastern portion of this lineament where a fault separates Wabigoon metavolcanics from Quetico metasediments, and this usage has been continued in reports of the Ontario Geological Survey (Shklanka 1972; Pirie 1978; McIlwaine and Chorlton 1973; McIlwaine and Hillary 1974; Fumerton 1980). Along the western extension of this lineament, Davies (1973) applied the name Quetico Fault to a mylonite zone which occurs predominantly in granitic rocks, coincident with the lineament recognized by Parkinson (1962). Davies (1973) also proposed the term *Seine River Fault* for another, more southerly, major fault that separates Wabigoon metasediments and metavolcanics from Quetico metasediments. This terminology was adopted by Mackasey *et al.* (1974), Wood (1980), and Wood *et al.* (1980).

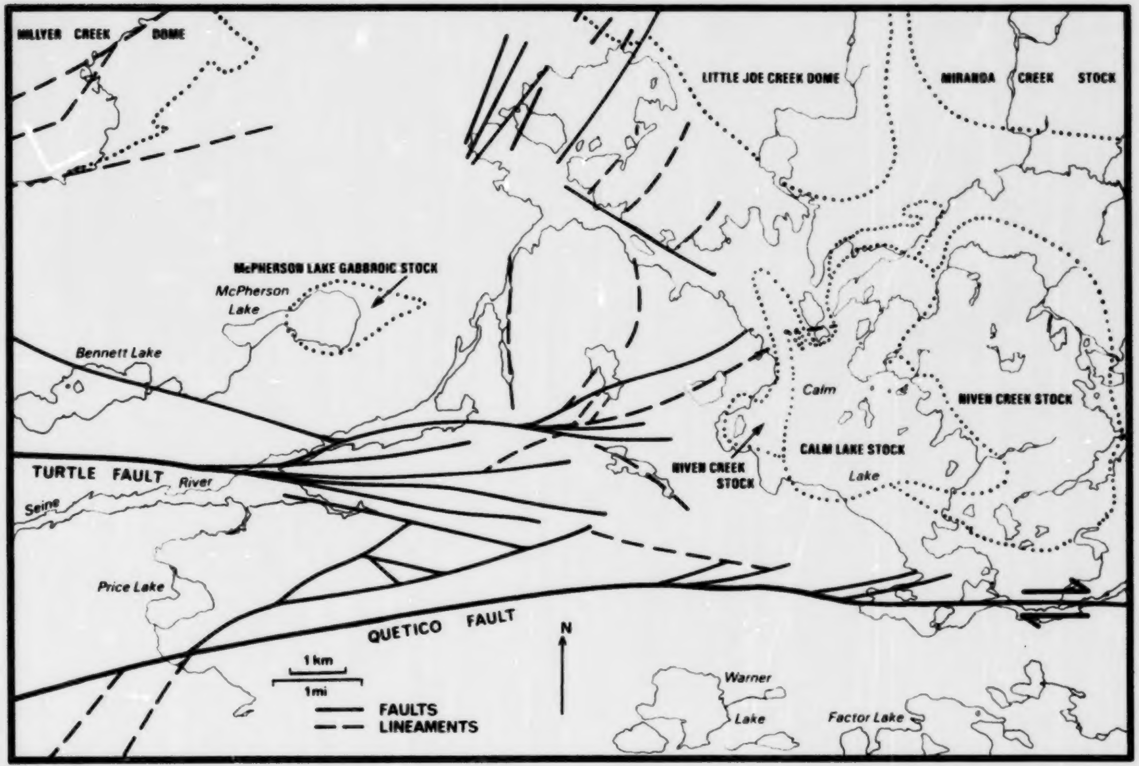
Within the map-area the Quetico metasediments are separated from the Wabigoon metavolcanics and Seine "Series" metasediments by a narrow (less than 10 m wide) though continuous lineament. On the ground this lineament is generally inconspicuous and in the vicinity of Price Lake and Banning Narrows commonly has rocks of a similar colour and grain size on either side. During the present survey, sheared and comminuted rocks were mapped near the lineament, particularly between Banning Narrows and Gehl Lake, but most of these shear zones trend approximately N70E, at an oblique angle to the lineament. Furthermore, the larger oblique shear zones are confined to the Wabigoon metavolcanics, in contrast to the small shear zones which transect the rocks on either side of the lineament.

Opposing stratigraphic top directions in the Wabigoon metavolcanics and the Quetico metasediments, together with truncated folds in banded ironstone (see Figure 12) indicate that this inconspicuous lineament which separates these two lithologies is in fact a major wrench fault. This fault is continuous with the Quetico Fault to the east. However, to the west, this same fault is continuous with the one termed the *Seine River Fault* by Davies (1973) (see Figure 8).

Because of precedent, and also because of general acceptance of the name Quetico Fault as the major fault in the region, it is suggested that the use of the name Seine River Fault be discontinued, and that the name Quetico Fault be applied to the full length of this fault (Figures 8 and 9).

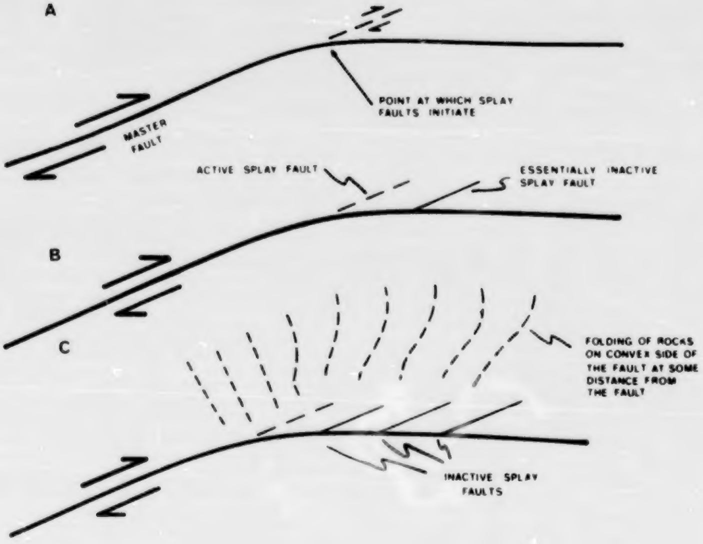
Drag folds asociated with movement along the Quetico Fault are outlined by banded ironstone units at Calm lake, and indicate that right lateral slip occurred along the fault plane. This is in agreement with observations of Hawley (1930), and Schwerdtner *et al.* (1979). Furthermore, the location of the oblique shear zones or splay faults which trend N70E at a bend in the Quetico Fault also favours a right lateral movement. The hypothesis is that the splays were initiated at the west end and on the convex side of the bend in the master fault and acommondated some right lateral movement which, together with folding of the rocks, permitted a shift in the direction which adjacent rocks moved along the main fault. As the right-lateral movement along the master fault proceeded, new splay faults were generated and slip along the earlier faults diminished (Figure 10).

Faults and shear zones parallel to the main Quetico Fault, together with faults parallel to a fault trending N55E which occurs east of Price Lake, are thought to be related to the Quetico Fault (see Figure 9). Some of the faults parallel to the Quetico Fault are truncated by some faults trending N55E but other faults parallel to the Quetico Fault truncate some faults trending N55E. All N55E faults are in turn truncated by the Quetico Fault, suggesting that the faults parallel to the Quetico Fault and those trending N55E were probably formed during an early stage of movement along the Quetico Fault system.


HILLYER CREEK DOME
LITTLE JOE CREEK DOME
MIRANDA CREEK STOCK
McPHERSON LAKE GABBROIC STOCK
McPherson Lake
Bennett Lake
Calm
NIVEN CREEK STOCK
CALM LAKE STOCK
Lake
NIVEN CREEK STOCK
TURTLE FAULT
River
Seine
Price Lake
QUETICO FAULT
N
1 km
1 mi
FAULTS
LINEAMENTS
Warner Lake
Factor Lake

SMC 15297

Figure 9. *Fault and lineament pattern in the Calm Lake area.*


A
POINT AT WHICH SPLAY FAULTS INITIATE
MASTER FAULT
ACTIVE SPLAY FAULT
ESSENTIALLY INACTIVE SPLAY FAULT
B
C
FOLDING OF ROCKS ON CONVEX SIDE OF THE FAULT AT SOME DISTANCE FROM THE FAULT
INACTIVE SPLAY FAULTS

SMC 15298

Figure 10. *Inferred manner of formation of splay faults associated with a bend in the master fault.*

LITTLE TURTLE FAULT SYSTEM

The Little Turtle Fault system consists of a major east-trending wrench fault that splits into a number of east-trending splay faults at the Seine River (see Figure 9). As discussed in the previous section, this was formerly termed the Quetico Fault, an inappropriate name because none of the splay faults connect with the eastern extension of the Quetico Fault. It is suggested that the fault be renamed the Little Turtle Fault, after Little Turtle Lake where this fault is well exposed (Fumerton 1982).

The main fault and splay faults of this system are typified by intense schistosity along the fault planes, all of which have steep dips, and by the extreme elongation of any primary textures in the adjacent rocks. This is particularly noticeable in conglomerate and tuff-breccia. A point of note with regards to the splay faults trending east to southeast, is the abrupt termination of recognized faults and the absence of associated schistosity east of the creek which drains Long Lake into Mills Creek. The splay faults which trend north of east become progressively less significant to the east, but some splay faults and associated lineaments appear to have been truncated by the emplacement of the Calm Lake Stock.

In the vicinity of Mills Creek some splay faults related to the Little Turtle Fault appear to truncate faults of the Quetico Fault system. However, other faults of the Little Turtle Fault system are truncated by faults of the Quetico Fault system. Therefore, these two fault systems are at least in part coeval, and may possibly be part of a single wrench fault system. It is possible that this system is located on some early crustal weakness, the nature of which is unknown.

No sense of movement was determined along the Little Turtle Fault proper. However, a left-lateral movement along a splay fault has been documented at Twin Lakes. Such a sense of movement is opposite to that determined for the Quetico Fault. In addition to this lateral movement it is possible that there has been an uplift of the north side relative to the south side, and that this uplift increases in magnitude to the west. This has been inferred from the state of preservation of the supracrustal rocks to the north of the fault. Within the Calm Lake area, primary textures are present in these rocks near to the fault, but to the west these rocks are progressively more migmatized and granitized (Wood *et al.* 1980; Blackburn 1973) suggesting that a lower crustal level is exposed. If this is valid, then the Little Turtle Fault could be classified as a hinge fault in the vicinity of Calm Lake, the hinge being contained within the map-area. However, drag folds associated with movement along this same fault further west, as documented in mapping by Davies (1973), Blackburn (1973), and Harris (1974), clearly indicate a right lateral component of movement.

FAULT SYSTEM AT HEPBURN BAY

At Hepburn Bay a number of subparallel faults trend N25E. No displacement was recognized along most of these faults. One fault which transects the margin of Little Joe Creek Dome has a left-lateral movement at its northern end, but no displacement is apparent at the southern end of the fault. All these faults occur in valleys with steep scarps and there is little evidence of comminution or shearing along the fault plane.

Folds

Large folds occur in the Wabigoon Subprovince and extend for considerable distances north and west of the map-area. In contrast, only minor folds and kink folds were recognized within the Quetico Subprovince. All these folds, except the drag folds associated with the Quetico Fault, predate the faulting within the map-area.

SYNCLINES

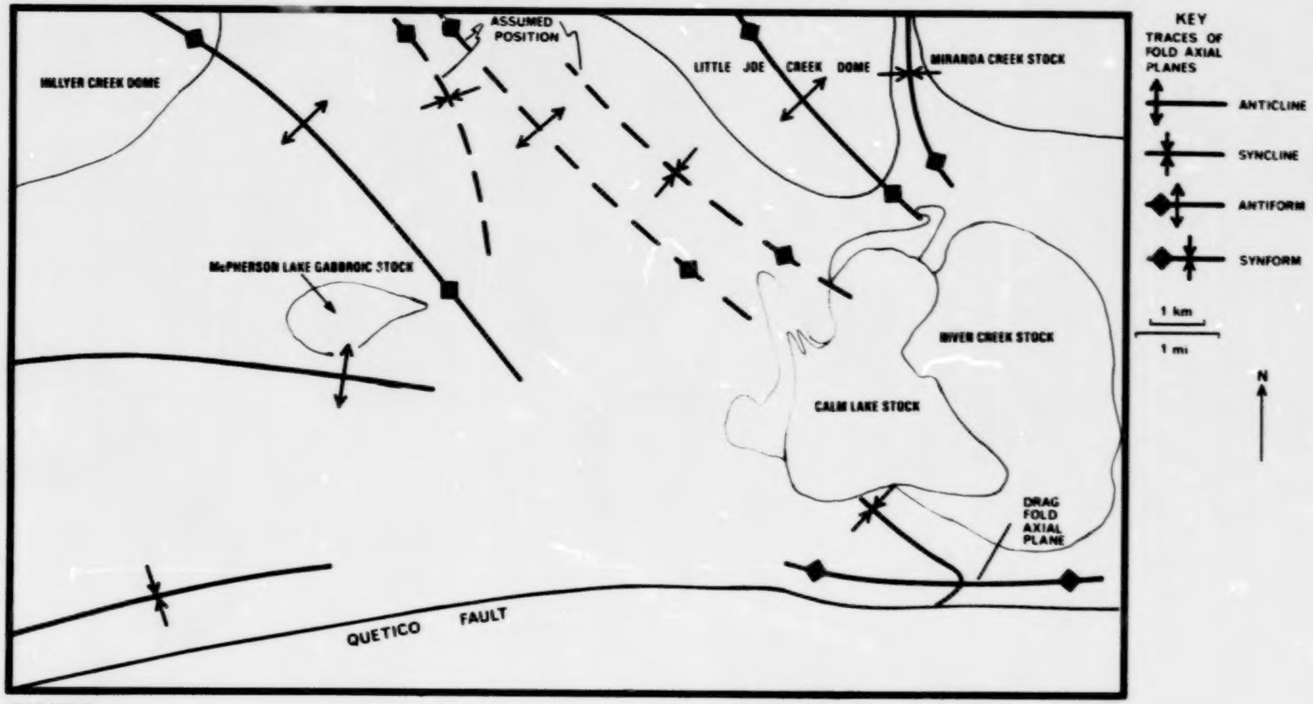
Stratigraphic top determinations have delineated two synclines. The first is in the Seine "Series" metasediments and the second within the metavolcanics and metasediments at Calm Lake.

Cross-bedding and graded bedding within the Seine "Series" metasediments indicate that an axial plane to a vertical isoclinal syncline passes through Price Lake trending N70E, parallel to the Quetico Fault (Figure 11), and that the fold axis plunges at a shallow angle to the west. The southern limb of this fold is truncated by the Quetico fault close to the hinge zone of the fold. The northern limb is folded into a minor fold with a hinge approximately coincident with the occurrence of metavolcanics south of the Seine River, and the northern limb of this minor fold is truncated by the Little Turtle Fault.

The second syncline, at Calm Lake, is not well defined, and is truncated by the Calm Lake granite. Figure 12 is a speculative reconstruction of this syncline prior to the intrusion of the granite stock. The main marker defining this fold is the metasedimentary-metavolcanic contact which indicates that the fold axis is near vertical. As discussed previously the Calm Lake metasediments overlie the metavolcanics. This syncline has been refolded by a drag fold associated with movement along the Quetico Fault and is truncated by the fault itself.

ANTIFORMS

Two antiforms trend southeast from the Hillyer Creek and Little Joe Creek Domes (see


HILLYER CREEK DOME
ASSUMED POSITION
LITTLE JOE CREEK DOME
MIRANDA CREEK STOCK
McPHERSON LAKE GABBROIC STOCK
RIVER CREEK STOCK
CALM LAKE STOCK
DRAG FOLD AXIAL PLANE
QUETICO FAULT
KEY
TRACES OF FOLD AXIAL PLANES
ANTICLINE
SYNCLINE
ANTIFORM
SYNFORM
1 km
1 mi
N

SMC 15299

Figure 11. *Position of axial planes to anticlines, synclines, antiforms and synforms within the part of the Wabigoon Subprovince in the Calm Lake area.*

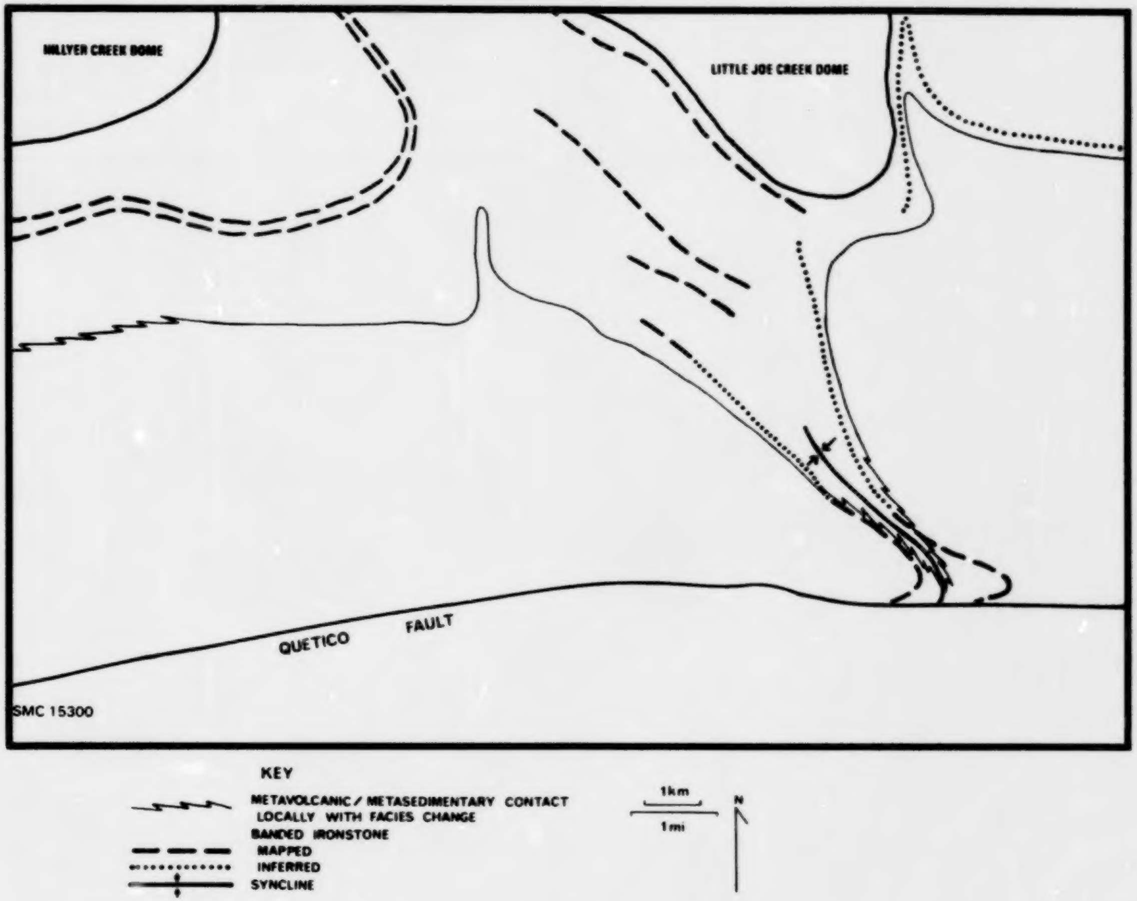

HILLYER CREEK DOME
LITTLE JOE CREEK DOME
QUETICO FAULT
SMC 15300
KEY
METAVOLCANIC / METASEDIMENTARY CONTACT LOCALLY WITH FACIES CHANGE
BANDED IRONSTONE
MAPPED
INFERRED
SYNCLINE
1km
1mi
N

Figure 12. *Speculative form of the sedimentary-volcanic contact prior to the emplacement of the Calm Lake and Niven Creek Stocks.*

Figure 11) and are probably related to the formation of these domes. Within the map-area, the fold axes to these domes plunge vertically or steeply to the southeast. As has been discussed previously, the metasediments overlie the metavolcanics, and because the metasediments occur between the domes and the metavolcanics it may be that both these domes intruded into an inverted sequence, similar to that at Rice Bay, described by Poulsen *et al.* (1980). However, top determinations are too restricted to prove this hypothesis.

The axial planes to both domes transect the main metasedimentary-metavolcanic contact but the amplitude of the folded contact is considerably smaller than the amplitude of the domes (see Figure 12). This suggests that the intensity of the folding related to these two antiforms diminished away from the domes.

It is suggested by the author that another antiform related to the two antiforms discussed above may exist within the map-area (see Figure 11). Folding about such an axial plane would tighten the fold pattern of the adjacent synclines.

The positions of synforms separating the proposed antiforms have been inferred in Figure 11 although evidence of their presence was not observed in the field.

An antiform between Bennett and McPherson Lakes separates the north-facing metavolcanic-metasedimentary contact at McPherson Lake from the south-facing metavolcanics adjacent to the Little Turtle Fault. However, its precise position is unknown.

STRUCTURES WITHIN THE QUETICO SUBPROVINCE

No major folds or faults were recognized within the Quetico Subprovince; the only macroscopic structures identified are the two lineaments south of Price Lake. The orientation of the bedding is consistent on a large scale trending N70E to east, though some small folds do occur locally. Throughout the map-area, the stratigraphic top directions within these metasediments are towards the north. Typically, the foliation in the rocks parallels the bedding, but locally the foliation is oriented up to 20 degrees anticlockwise to the bedding.

Minor kink folds are present in the northern part of the metasediments. The kink axes are contained within the bedding plane and have steep plunges.

Summary of Tectonic and Stratigraphic Events

Structurally, the Quetico Subprovince is characterized by steeply dipping metasediments with stratigraphic tops consistently to the north. The Seine River wedge within the map-area consists of a vertical isoclinal syncline with near-horizontal axis which is bounded by faults. In contrast to this simplicity, the remainder of the Wabigoon Subprovince is structurally complex, characterized by two or more periods of folding, intrusion of several plutonic bodies, and extensive faulting.

The tentative sequence of tectonic and stratigraphic events within the Wabigoon Subprovince proposed by the author is as follows.

(1) Deposition of the volcanic rocks on an unknown basement.

(2) Deposition of the Calm Lake sediments on the volcanic rocks. In places the contact between the volcanic and sedimentary rocks is gradational; in places it is unconformable and marked by conglomerates; and in other places a facies change marks the transition from volcanic to sedimentary rocks. The Calm Lake metasediments are possibly equivalent to the Seine "Series" metasediments.

(3) The supracrustal rocks were folded and possibly overturned.

(4) Plutonic stocks of granite and leuco-tonalite intruded these supracrustal rocks.

(5) The total assemblage of rocks was then refolded, probably in conjunction with

regional amphibolite grade metamorphism, and migmatization of the metasediments.

(6) Emplacement of the McPherson Lake mafic stock.

(7) Emplacement of the diorite to tonalite, Miranda Creek and Niven Creek Stocks.

(8) Major period of wrench faulting resulting in the formation of the Quetico and Little Turtle fault systems.

(9) Emplacement of the Calm Lake granite stock.

These were probably not discrete events, but rather, parts of a continuous evolving tectonic process which overlapped in time.

DISCUSSION OF GEOPHYSICAL DATA

Aeromagnetic Data

The aeromagnetic data available were used to extrapolate geological field observations, especially in areas of poor outcrop.

A comparison of the geological map with the aeromagnetic maps (ODM-GSC 1961) shows a good correlation. The Quetico Fault is coincident with a pronounced change in the magnetic susceptibility of the underlying rocks on either side of the fault. The Quetico Subprovince is characterized by a very flat magnetic signature, of low intensity (less than 60 300 gammas). Within the Wabigoon Subprovince a number of major geological structures correlate with patterns on aeromagnetic maps which vary greatly in their magnetic susceptibility. Firstly the Seine River wedge can be identified by its flat magnetic signature (approximately 60 400 gammas) bounded on the south by the Quetico Subprovince with its even lower magnetic susceptibility, and bounded on the north by the high and erratic magnetic intensity of the metavolcanics and metasediments. The "steps" that bound the flat magnetic signature of the Seine River wedge coincide with major faults. Within the Wabigoon Subprovince proper, the various felsic plutonic bodies have a low magnetic susceptibility, for example the Hillyer Creek Dome, the Little Joe Creek Dome, the Miranda Creek Stock, and a tonalite stock north of McPherson Lake. Consequently these stocks coincide with contoured depressions on the aeromagnetic maps. However, of note is that the Niven Creek dioritic stock and the McPherson Lake mafic stock have high magnetic susceptibilities and coincide with positive contoured anomalies. The peculiarity in this is that similar lithologies in the Miranda Creek and Niven Creek Stocks give rise to opposite magnetic responses, a difference which can not simply be explained by the noted greater abundance of diorite in the Niven Creek Stock. Another peculiarity is that the Calm Lake granite stock does not have an identifiable magnetic signature.

The remaining metavolcanics and metasediments in the Wabigoon Subprovince have a wide range in their magnetic susceptibility (60 200 to greater than 67 000 gammas). However, this range is largely due to the presence of underlying banded magnetite ironstone coincident with all the high magnetic anomalies. The intensity of the magnetic field around these thin and folded beds obscures any identification of more subtle signatures which could aid structural interpretation.

Recent and more detailed aeromagnetic maps (OGS 1980) have a higher resolution and generally a higher degree of correlation with the geological map. Hence a number of additional points can be made.

Firstly, some linear magnetic trends are associated with faults and lineaments as noted on the earlier maps. The recent maps have a number of magnetic trends coincident with a few splay faults that emanate from the Little Turtle Fault. These trends do not extend east of Long Lake, which is in agreement with the observed lack of shearing east of Long Lake. Another magnetic high linear trend is coincident with the topographical lineament along the south contact of the Hillyer Creek Dome. An extension of this lineament is coincident with a break in the strong magnetic anomaly over the units of banded ironstone west of Hepburn Bay. This implies that the lineament is in fact a fault extending from west of the map-area to Hepburn Bay. The recent aeromagnetic survey has led to the identification of another fault along an observed topographical lineament. This particular lineament trends N70W and extends from the Seine River through Bennett Lake and to the northwest. Evidence for a fault along this lineament is the dissimilarity in the magnetic signature on either side of the lineament.

Secondly, the recent aeromagnetic work permits the correlation and extension of some banded ironstone beds, particularly in the vicinity of Little Joe Lake. Of particular interest is the possible merging of the banded ironstone beds west of Hepburn Bay, which strike north, with the banded ironstone beds which strike southeast and extend to Gull

Rocks. The coalescence of the magnetic fields around these ironstone beds occurs at the edge of the surveyed area so the problem cannot be fully analysed. However, if these beds do merge the interpretation on the geological map would be incorrect west of Hepburn Bay.

Finally, the recent aeromagnetic maps reveal that the metavolcanics generally have a constant magnetic intensity, and that the Calm Lake metasediments have an erratic magnetic intensity. This is particularly so for the metasediments adjacent to the metavolcanics between Calm Lake and Bennett Lakes. Consequently, the position of the metasedimentary-metavolcanic contact can be approximately identified from these aeromagnetic maps.

Airborne Electromagnetic Data

A comparison of the geological map with the airborne electromagnetic maps (OGS 1980) shows that conductors can be correlated with faults and lineaments. Firstly, a very strong conductor is coincident with the lineament/fault south of the Hillyer Creek Dome. Secondly, strong conductors occur along some of the Little Turtle splay faults, but their intensity diminishes towards the west. Finally, strong conductors coincide with parts of the Quetico Fault. These conductors could be explained by pyrite and/or graphite, and/or water within the shear zones.

Strong conductors occur along the contact of the Miranda Creek Stock with the adjacent supracrustal rocks and along the contact of the metavolcanics with metasediments between Calm Lake and Bennett Lake. No explanation for conductors occurring at these contacts can be forwarded from field observations.

The strong conductors southeast of Mid Island and north of Gehl Lake are explained by the observed pyrite and graphite in thin beds. In the Mid Island occurrences these beds are in close proximity to banded ironstone, and therefore, it is possible that the conductors east of Little Joe Lake could also be explained by the occurrence of graphite and pyrite beds close to the banded ironstone units in the area.

Numerous other electromagnetic conductors cannot be explained by geological features observed during the present survey, or by association with structural features. However, of note are the large number and intensity of anomalies at, and to the north of Bennett Lake, an area with known gold occurrences, and an anomalous zinc value in a grab sample.

ECONOMIC GEOLOGY

Records of early exploration in the map-area are very limited. The only indication of exploration, aside from the development of the Independence mine and the Mayflower prospect, is from the number of patented claims which were privately held in Bennett Township and optioned to various mining companies between 1890 and 1920. Presumably this exploration formed part of the gold exploration activity that occurred in the Mine Centre area during the same time.

Since this early work, limited exploration has been carried out in the area and this has been concentrated in the metavolcanics and metasediments of the Wabigoon Subprovince. Gold, iron, and recently base metals have been the metals sought after, and to date four gold occurrences and numerous iron occurrences have been discovered.

Gold

The four known gold occurrences are the Independence mine, the Cedar Lake prospect, the Mayflower prospect, and the Law occurrence. The Independence mine and Cedar Lake prospect are located to the north of Bennett Lake and are underlain by a complex assemblage of metavolcanics and metasediments, both epiclastic and chemical, which have been intruded by granitic dikes, and are transected by shear zones. At the Independence mine, gold occurs within a quartz vein and the adjacent felsic crystal tuff. At the Cedar Lake prospect, gold occurs in shear zones but is not necessarily concentrated in quartz veins within the shear zone.

At the Mayflower prospect, located south of the railway 1.5 km west of Flanders, low grade gold mineralization occurs in an extensively carbonatized and silicified metavolcanic aureole surrounding a tonalite stock. High values occur erratically in quartz veins within this aureole and are associated with massive and disseminated pyrite and lesser amounts of galena, sphalerite, arsenopyrite, and chalcopyrite. Wilkinson (1980) also reported the presence of scheelite in this deposit. A similar geological setting is exposed in a road cut along a lumber road west of Gehl Lake, i.e. brecciated tonalite surrounded by carbonatized metavolcanics. A sample from this tonalite was assayed by the Geoscience Laboratories, Ontario Geological Survey, Toronto, but contained only trace concentrations of Au, Ag, Cu, Pb, Ni, and Zn.

Minor gold mineralization at the Law occurrence is found in small shear zones and quartz veins with associated pyrite, pyrrhotite, chalcopyrite and silver. Quartz veins between Indiaonta and Long Lakes have been prospected for gold without recorded success.

Base Metals

Sparsely disseminated sulphides occur in most metavolcanics but no significant concentrations were noted. Intercalated with the metavolcanics near Gehl Lake and the metasediments near Gull Rocks are some thin units of graphitic metasediments which contain abundant pyrite, however, no significant base metal mineralization was found associated with this rock type. Five selected grab samples of this unit were analyzed by the Geoscience Laboratories, Ontario Geological Survey, and the results are given in Table 4.

The conglomerate cemented by pyrite and described by Young (1960) from the vicinity of Mid Island could not be located.

On the north shore of a small lake about 1200 m north of McPherson Lake, subhedral crystals of ilmenite up to a centimetre across are disseminated within hornblende gneiss.

Significant base metal concentrations were obtained from a sample of the rusty

TABLE 4. TRACE ELEMENT ANALYSES (PPM) OF PYRITIFEROUS, GRAPHITIC METASEDIMENTS NEAR GULL ROCKS, CALM LAKE.

Sample	Co	Cr	Cu	Ni	Pb	Zn
111B	<5	<5	14	<5	<10	68
119A	<5	103	17	<5	<10	13
119B	<5	131	36	<5	10	18
121A	<5	<5	20	<5	<10	190
121B	<5	<5	18	<5	<10	147

NOTE: Analyses by Geoscience Laboratories, Ontario Geological Survey, Toronto.

stained weathered surface of metasediments on the north shore of Bennett Lake. These concentrations are Zn 3340 ppm, Pb 700 ppm, and Cu 300 ppm (analyses by Geoscience Laboratories, Ontario Geological Survey).

Iron

Numerous units of banded ironstone occur in the map-area, but most bands are considerably smaller than the maximum known thickness of 1 m. The iron is predominantly in the form of magnetite and to a lesser extent hematite, iron silicates, and pyrite. Intercalated with these bands are thin siltstone and recrystallized quartz bands which dilute the grade of magnetite in the rock. Consequently the potential for mining iron in this area is slim because of the poor grade rather than the lack of occurrences.

Description of Properties

ANDOWAN MINES LIMITED [1946] (HIDDEN TREASURE "MINE") (1)

In 1958 Andowan Mines Limited held seven patented claims (FF 4300 to 4305 inclusive and FF 4320) plus a number of mining claims which extended east and west of the patented claims along the railway near Flanders. This ground covered the Mayflower prospect and the Hidden Treasure "Mine". The former is presently held by K.J. McTavish and is described below. The Hidden Treasure "Mine" is located about 200 m north of the railway, about 2 km west of the Mayflower prospect, but none of the workings could be located by the present field party. According to Bow (1901) this property was held by the Rainy River Development Company of London and a shaft 21 m deep with a 5 m cross-cut was sunk in 1899. No mention of any production or gold values was made in Bow's report. Subsequently, Animikie Mines Limited carried out work including geological reconnaissance of the area surrounding the Hidden Treasure "Mine" in 1936 (Regional Geologist's files, Ontario Ministry of Natural Resources, Thunder Bay). The quartz veins on this former property are near a zone of shearing related to the Little Turtle Fault, and near a contact between mafic to intermediate metavolcanics and felsic metavolcanics with numerous intercalated banded ironstone and siltstone layers.

In 1945 Andowan Mines Limited aquired this property as part of a claim group including the Mayflower prospect but did not do any further work on the area to the west of the Mayflower propect. In the same group Andowan Mines also held ground to the east of the Mayflower prospect which was explored under an option agreement with Freeport Exploration Company Limited in 1946. During this work a grid was cut to cover the Mayflower prospect and extended about 900 m east of the prospect. Three diamond drill holes totalling 198 m intersected extensive shearing of metavolcanics associated with a splay of the Quetico Fault and minor quartz veins. Traces of gold were found in most veins and shear zones. Some quartz veins, mineralized with pyrite and sparse chalcopyrite, or shear zones with graphite contained up to 0.02 ounces Au per ton for up to 1.5

m (Regional Geologist's files). No further work was carried out on ground away from the Mayflower prospect and the ground has since reverted to the Crown.

R.R. BROWN AND ASSOCIATES [1954] (2)

In 1954 R.R. Brown together with J.E.V. Auger, H.D. McLeod, L.V. Herbert, and W.J. McMillan held 125 claims centred on Blind Pig Bay. All of the claims have since lapsed. A total of nine diamond drill holes were drilled during the spring and summer of 1954 for a total of 3430 m. This drilling delineated an extension of the granitic bodies at Calm Lake and a number of banded ironstone units, however, the objective of this drilling program is not clear and no assays are known to have been made.

CANADIAN NICKEL COMPANY LIMITED [1976] (3)

In 1976 Canadian Nickel Company Limited held four claims south of Fin Bay which have since lapsed, and drilled one diamond drill hole to a depth of 73 m. This hole was drilled to test a conductor within the metavolcanics and intersected a graphite layer and a number of pyritic units within the metavolcanics (Regional Geologist's files, Ontario Ministry of Natural Resources, Thunder Bay).

R.A. CLARK (4)

In November of 1979 R.A. Clark staked two claims near Moonshine Lake to tie onto staking done for Shell Canada Resources Limited. To date no assessment work has been submitted.

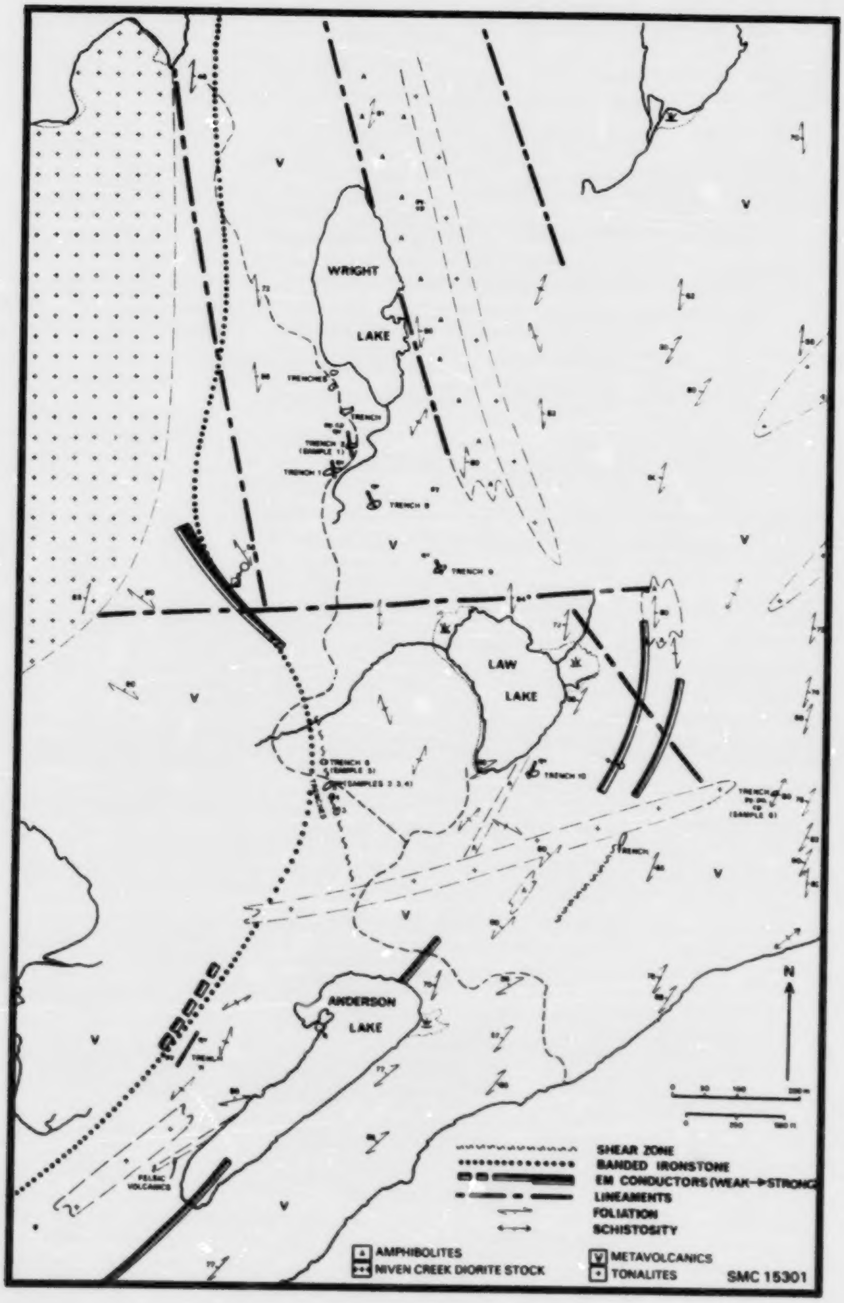
LAW OCCURRENCE (5)

The Law occurrence comprises a number of sulphide showings situated between Banning Narrows and Niven Lake along the eastern boundary of the area. Since these showings were originally discovered in the 1920s they have been repeatedly staked by various prospectors, and on occasions the property has been optioned to exploration companies. Currently none of the ground is staked.

Tanton (1926) reported that a Mr. Law found the original gold-chalcopyrite occurrence, and Hawley (1930) reported that exploration work was being carried out by the Law Syndicate in 1929. For the period between 1929 and 1956 there are no records of any exploration on the occurrence. During 1956, Moneta Porcupine Mines Limited carried out a restricted geological mapping and ground magnetic surveying program but no encouraging results were reported (Regional Geologist's files, Ontario Ministry of Natural Resources, Thunder Bay). In 1956, Cominco Limited remapped the ground and did an electromagnetic survey of the area, and put down three diamond drill holes for a total of 150 m. These holes were sited so as to intersect electromagnetic conductors. The mineralized rocks intersected consisted of silicified and graphitic zones up to 3 m thick with massive pyrite, pyrrhotite and trace amounts of chalcopyrite. These were analyzed for copper and gold, but no significant amounts were detected.

The sulphide showings occur within quartz veins or minor shear zones in mafic metavolcanics intercalated with banded ironstone and felsic metavolcanics. These rocks have been folded and the occurrence is in the core of a large fold which occurs primarily east of the present map-area (Fumerton 1980). The metavolcanics have been intruded by a number of mafic dikes, and felsic dikes and stocks. The rocks around the showings have been cut by shear zones.

In the northern group of trenches near Wright Lake (Figure 13, trenches 1, 2, 8) the



WRIGHT LAKE
LAW LAKE
ANDERSON LAKE
TRENCH 8
TRENCH 9
TRENCH 10
TRENCH 1
FELSIC VOLCANICS
V
N
SHEAR ZONE
BANDED IRONSTONE
EM CONDUCTORS (WEAK→STRONG
LINEAMENTS
FOLIATION
SCHISTOSITY
AMPHIBOLITES
NIVEN CREEK DIORITE STOCK
METAVOLCANICS
TONALITES
SMC 15301

Figure 13. *Geological sketch map of the Law occurrence. Geology by S.L. Fumerton, 1979 and 1980, supplemented by information from Hawley (1930) and Regional Geologist files, Ontario Ministry of Natural Resources, Thunder Bay.*

host rocks consist of compositionally banded and homogeneous tuffs which are strongly foliated or sheared parallel to the banding where present. Quartz veins, mineralized with chalcopyrite and pyrite are parallel to the foliation, but are discontinuous, and are up to 25 cm thick. The total sulphide concentrations range from trace amounts to 2 percent, and the veins tend to be concentrated into 1 m thick bands. In the southern group of trenches (Figure 13, trenches 3 to 6, west of Law Lake) sparsely disseminated pyrite and pyrrhotite, and trace amounts of chalcopyrite occur in bands of highly sheared and altered rock which trend north. The shear zones are up to 3 m thick and contain unmineralized quartz veins less than 2 cm thick that parallel the shear zones. Abundant disseminated carbonate occurs throughout the shear zones. Laterally these shear zones grade into unsheared fine-grained basalts. Six selected grab samples were taken from the Law occurrence and the results are listed in Table 5.

TABLE 5. ASSAYS OF SELECTED GRAB SAMPLES FROM TRENCHES ON THE LAW OCCURRENCE.

Sample	Au	Ag	Ba	Co	Cr	Cu	Ni	Pb	Zn
1	0.01	Tr	90	31	109	6100	50	102	69
2	Tr	0.24	80	190	550	810	1080	—	40
3	Tr	—	40	45	1650	420	560	20	64
4	Tr	—	20	71	1810	380	500	13	40
5	Tr	—	190	30	580	640	340	32	76
6	0.01	Tr	100	54	440	240	113	18	60

NOTES
Assays by Geoscience Laboratories, Ontario Geological Survey, Toronto. Au and Ag givenin ounces per ton; other elements in parts per million.
Tr - trace; — - not detected.

SAMPLES (locations are given in Figure 13)

1. Fine-grained quartz with lenses of chlorite and host rock. Some sulphides andCu-Fe stain.
2. Strongly sheared fine-grained mafic tuff with 3% sulphides (pyrite, pyrrhotite, chalcopyrite).
3. Similar to sample 2.
4. Similar to sample 2, but also contains small quartz veins.
5. Similar to sample 2, but also contains small quartz veins.
6. Strongly foliated, fine-grained rock with 1% sulphides.

R.J. MACLEAN *ET AL.* (INDEPENDENCE MINE) (6)

The MacLean property, located north of Bennett Lake, consists of four lots purchased by J.A. Kennedy *et al.* in 1915 (northern and southern parts of lot 11, concession II; southern part of lot 11, concession III; and part of lot 12, concession II) and currently held by R.J. MacLean Jr., E. Walton, M.J. Strangis, A.E. Dalby, and J.W. Richardson. Excluded from this ground are two patented claims (HP 241 and HP 245) which were surveyed in 1897 but lapsed in 1910 and are currently open for staking.

According to Bow (1899a), the Independence Mining and Development Company Limited started work on the occurrence in 1896, and in 1898, 125 tons of gold ore worth $1906 was produced (Ferguson *et al.* 1971; price of gold in 1898 was $18.69 per ounce). Bow (1899a) gave the following description of this mine:

> The main workings of the mine are on lot 11 on the third concession, where a shaft six by eight feet in cross-section has been sunk 75 feet. As this was only for prospecting purposes, it will likely be abandoned and a working shaft sunk at a more convenient point close by on the strike of the same pay streak. The latter, on which the the shaft is sunk, is a body of quartz heavily mineralized with copper and iron pyrites, from six to 24 inches in width and traceable for 50 or 60 feet on the surface. The vein dipped south, leaving the shaft at a depth of a few feet, but the latter was continued vertical. As the lower workings were full of water I could not go down, but the manager informed me that at a depth of 45 feet a cross-cut had been driven 10 feet south cutting the vein, and a drift had been driven 20 feet upon it. A cross-cut had also been driven three feet north from the shaft, making, with the width of the shaft, 19 feet of cross-cutting altogether. An average sample taken along this, excluding the pay streak, gave $7.35 per ton. The pay streak averages $145. A

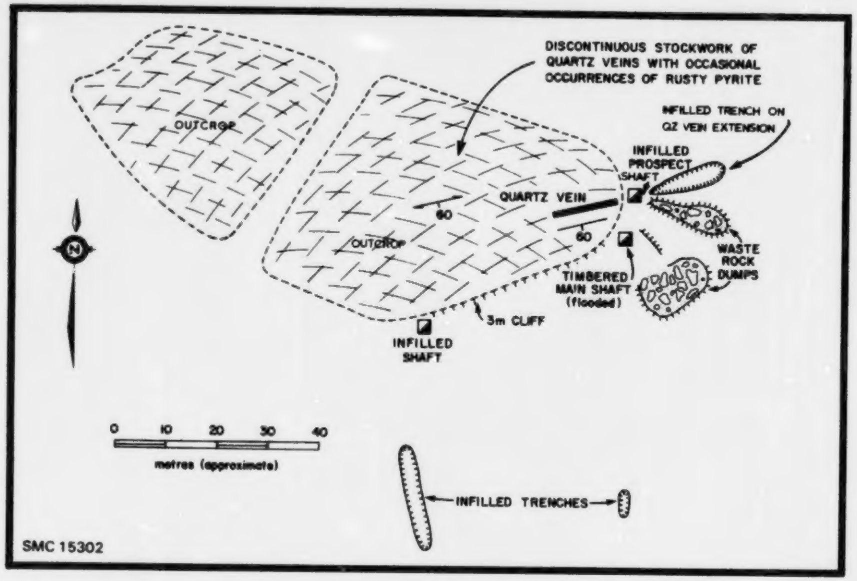

DISCONTINUOUS STOCKWORK OF QUARTZ VEINS WITH OCCASIONAL OCCURRENCES OF RUSTY PYRITE
INFILLED TRENCH ON QZ VEIN EXTENSION
INFILLED PROSPECT SHAFT
OUTCROP
OUTCROP
60
QUARTZ VEIN
60
WASTE ROCK DUMPS
TIMBERED MAIN SHAFT (flooded)
3m CLIFF
INFILLED SHAFT
N
0
10
20
30
40
metres (approximate)
INFILLED TRENCHES
SMC 15302

Figure 14. Sketch map of the geology of main workings at the Independence mine. Geology by S.L. Fumerton.

TABLE 6. ASSAYS OF SELECTED GRAB SAMPLES FROM OUTCROP AND WASTE ROCK DUMPS NEAR THE MAIN WORKING OF THE INDEPENDENCE MINE. ROCKS CONTAINING QUARTZ VEIN MATERIAL ARE RARE IN THE ROCK DUMP.

Sample	Au	Ag	As	Mo	Cu	Pb	Zn	Ni	Cr	Co	Ba	W
992A	0.07	<2	2	<3	44	163	18	<5	<5	5	120	<500
992B	0.19	<2	<1	<3	130	<10	31	<5	<5	5	150	<500
992C	Tr	<2	<1	<3	40	<10	36	<5	<5	5	360	<500
992D	0.96	<2	<1	<3	265	<10	26	<5	<5	9	420	<500
992E	Tr	<2	<1	<3	152	<10	34	<5	<5	7	510	<500
992F	0.04	<2	<1	<3	75	<10	32	<5	<5	6	500	<500
992G	0.01	<2	<1	<3	136	<10	17	<5	<5	7	190	<500
992H	Tr	<2	<1	<3	126	12	10	<5	<5	<5	50	<500
992I	0.21	<2	<1	<3	380	<10	18	<5	<5	19	190	<500

NOTES

Assays by Geoscience Laboratories, Ontario Geological Survey, Toronto. Au given in ounces per ton; other elements in parts per million.

Tr - trace.

SAMPLES

992A. In situ quartz vein.
992B. Quartz vein with minor carbonate.
992C. Barren host rock.
992D. Stock work of quartz veins up to 2 cm thick in host rock.
992E. Thin stringers (< 1 mm) with pyrite and chalcopyrite in host rock.
992F. Sparsely disseminated pyrite in host rock.
992G. Fine network of quartz veins (< 1 cm) in host rock.
992H. Coarse-grained quartz vein with trace of pyrite.
992I. Quartz vein heavily mineralized with granular pyrite.

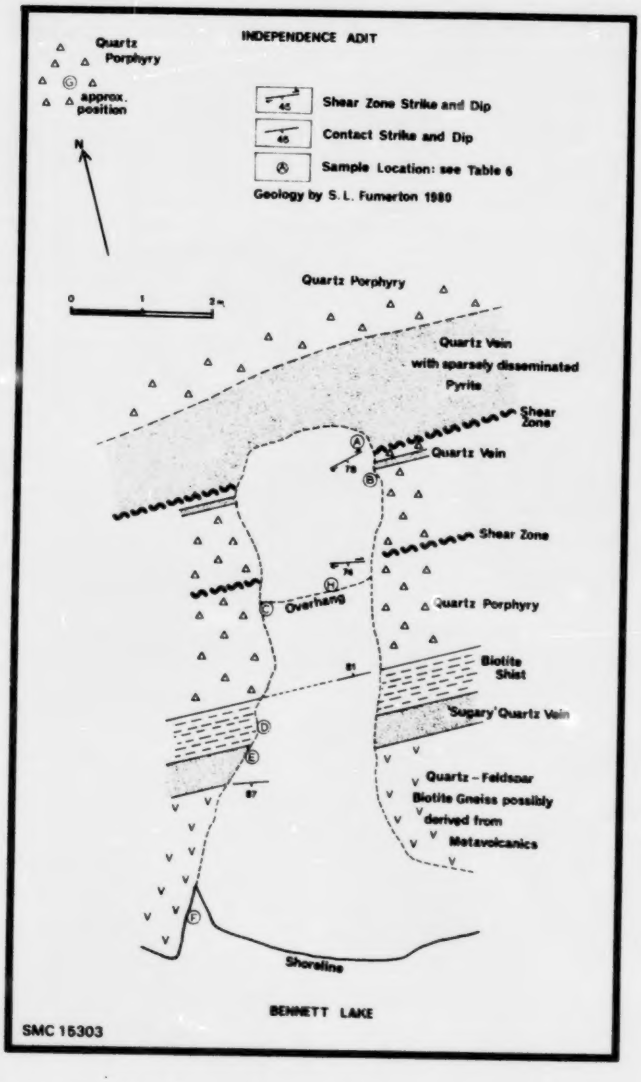

INDEPENDENCE ADIT
Quartz Porphyry
Ⓖ approx. position
45
Shear Zone Strike and Dip
45
Contact Strike and Dip
Ⓐ
Sample Location: see Table 6
Geology by S. L. Fumerton 1980
N
0
1
2 m
Quartz Porphyry
Quartz Vein with sparsely disseminated Pyrite
Shear Zone
Ⓐ
78
Quartz Vein
Ⓑ
Shear Zone
74
Ⓗ
Ⓒ
Overhang
Quartz Porphyry
81
Biotite Shist
'Sugary' Quartz Vein
Ⓓ
Ⓔ
87
Quartz – Feldspar Biotite Gneiss possibly derived from Metavolcanics
Ⓕ
Shoreline
BENNETT LAKE
SMC 15303

Figure 15. *Sketch map of the secondary adit at the former Independence mine property, north shore of Bennett Lake. Geology by S.L. Fumerton.*

> mill run of the dump, consisting of the material from the cross-cuts, including the pay-streak, gave $19.42 per ton. A couple of test pits had been sunk near the shaft, one 15 feet and the other six feet. About 40 feet of open-cutting four or five feet in depth had been done along the outcropping of the vein east of the shaft .
>
> On the south side of the property on the shore of Cedar lake a tunnel has been driven 16 feet north, cross-cutting a very siliceous altered schist, but the assays were low.

Besides this description there are no known descriptions detailing subsequent work on this property.

After the initial production in 1898 no further exploration work is known to have taken place on this property.

The precise location of the main workings appears to be in doubt. Bow (1899a) reported the main workings to be in lot 11, concession III. A pace and compass survey by the present field party located the main workings 60 m south of concession III in concession II and approximately 50 m from a patented claim (HP 245) which was originally surveyed in 1897 during the development of the main workings. Therefore, it is possible that the workings are contained within the boundaries of this patented claim, which is presently open for staking.

The main quartz vein is up to 18 m long on surface and up to 0.6 m thick (Bow 1899a). Presently this vein is poorly exposed and little vein material can be found in the nearby rock dumps (Figure 14). The host rock is felsic quartz crystal tuff in which the quartz clasts commonly have a blue tint. Within this rock numerous small, discontinuous quartz veins occur at various attitudes. The felsic tuff strikes east and is surrounded by a complex mixture of intercalated epiclastic and chemical metasediments and metavolcanics which might represent a sequence at a facies boundary.

Nine selected grab samples taken from the waste rock dump near the main workings were analyzed for a number of metals (Table 6) but only gold occurred in significant concentrations. Though the values listed in Table 6 are not as high as those reported by Bow (1899a), they are still encouraging and this occurrence warrants further investigation.

During the development of the main workings, the Independence Mining and Development Company Limited also developed a 16 m adit on the north shore of Bennett Lake (formerly called Cedar Lake) to prospect a quartz vein in porphyritic tonalite (Figure 15). Bow (1899a) mentioned that low values were obtained from this adit ("tunnel" in Bow 1899a). Seven grab samples collected during the present investigation are not encouraging (Table 7).

TABLE 7. ASSAYS OF SELECTED GRAB SAMPLES FROM INDEPENDENCE ADIT ON THE NORTH SHORE OF BENNETT LAKE.

Sample	Au	Ag	Cu	Pb	Zn	Ni	Cr	Co	Ba
840A	Tr	0.10	16	12	42	<5	6	8	170
840B	Tr	Tr	22	<10	18	<5	<5	<5	550
840C	Tr	Tr	10	49	22	<5	<5	<5	550
840D	Tr	Tr	74	<10	190	106	151	43	360
840E	Tr	Tr	132	<10	25	8	<5	10	200
840F	Tr	Tr	72	29	141	46	31	32	150
840G	Tr	Tr	78	12	16	<5	5	<5	720

NOTES
Assays by Geoscience Laboratories, Ontario Geological Survey, Toronto. Au and Ag given in ounces per ton; other elements in parts per million.
Tr - trace.

CALM LAKE AREA

K.J. MCTAVISH (MAYFLOWER PROSPECT) (7)

Location and Ownership

A former block of seven patented claims straddling the railway about 1.5 km west of Flanders enclosed the workings of the Mayflower prospect. These claims were forfeited in 1978 and the ground was then staked with six claims by K.J. McTavish, who is the current owner of the property. Access to the main workings is by skid road from Highway 11.

History of Exploration

In 1900 the Rainy River Development Company of London Limited was carrying out development work on this prospect. According to Bow (1901) this development consisted of a 27 m vertical shaft with 15 m of cross-cuts on the 13 m level in three directions and 13 m of drifts on the 23 m level in two directions. This work was carried out to test the mineralization in a 30 m long quartz vein in which Bow (1901) identified abundant pyrite and minor sphalerite.

In 1918 the Mining and Land Development Company commissioned a geological report of the Mayflower ocurrence by W.A. Preston who described the extensive carbonatization of the wall-rocks associated with the quartz-carbonate veins which were reported to contain pyrite, chalcopyrite, and galena mineralization. The following gold values were allegedly obtained by Preston from samples collected from the rock dump and graded according to type.

		$ per ton (1918)	ounces per ton
1)	Hard, tough, white quartz and carbonates, with very small cubes of pyrite and chalcopyrite, and traces of galena	17.60	0.85
2)	Dark rusty quartz	10.40	0.50
3)	Greenish quartz and carbonates, very little pyrite	8.00	0.39
4)	Bluish white quartz and carbonate; banded structure with pyrite and chalcopyrite	8.80	0.43
5)	Hard dark blue quartz and carbonates with much pyrite	13.00	0.63

Mayflower Gold Mines Limited dewatered the workings in 1928 and resampled the quartz vein. In one cross-cut on the first level, massive sulphides were reported up to 0.75 m wide and of unspecified length within the quartz vein. The gold values across this sulphide vein were reported to range between $20.40 and $56.18 per ton (at 1928 prices equivalent to 0.99 and 2.72 ounces Au per ton). At the second level the same apparent sulphide vein was tentatively traced for 9 m and maintained a width of approximately 0.9 m. Two channel samples across the sulphide vein had alleged values of $4.20 per ton (at 1928 prices, 0.20 ounces Au per ton), whereas another sample was $11.20 per ton (at 1928 prices, 0.54 ounces Au per ton). Lesser values were reported from quartz containing disseminated sulphides adjacent to the massive sulphide vein. Erratic gold values of between $44.12 and $0.20 per ton (2.13 and 0.01 ounces Au per ton at 1928 prices) were reported along the contact of the quartz vein with the adjacent metavolcanics.

In 1936 Animikie Mines Limited did some work on this occurrence but no record of this work has been found other than a geological sketch map.

Andowan Mines Limited obtained the property in 1944 and in 1945 sank two diamond drill holes to intersect the mineralized quartz vein in the vicinity of the established underground workings. The first hole intersected mineralization which might be an eastward extension of the sulphide vein exposed in the underground workings. Assays of 0.5 ounces Au per ton over 0.9 m and 0.10 ounces Au per ton over 1.5 m were reported about 4.5 m east of easternmost workings and between the two levels. The second hole intersected mineralization about 12 m northwest and 11 m southeast of the shaft. An assay of 0.23 ounces Au per ton over 0.6 m was reported 6 m northwest of the shaft, and assays of 5.96 ounces Au per ton over 0.4 m, and 0.26 ounces Au per ton over 0.9 m were reported in the metavolcanics to the southeast. The type of mineralization was not specified.

The underground workings were dewatered in 1946 and resampled by Freeport Exploration Company. This resampling program did not fully endorse the earlier results, as the reported gold values associated with the sulphide mineralization varied widely from trace amounts to $32.20 per ton (1.56 ounces Au per ton at 1946 prices). The locations of the maximum gold values obtained by Freeport Exploration do not correspond to the locations of the maximum gold values obtained by Mayflower Gold Mines Limited, which tends to suggest that the gold is unevenly distributed within the sulphide-bearing quartz vein, which apparently has Au values in the range of trace to 0.20 ounces per ton.

Freeport Exploration also carried out an extensive diamond drilling program in 1946. This work showed that the gold mineralization appears to be associated with an aureole of alteration adjacent to a saddle shaped tonalite intrusion (Figures 16a and 16b). The alteration aureole has its maximum development in the saddle and is associated with brecciation, small lit-par-lit tonalite intrusions, and abundant quartz and quartz-carbonate veins. The altered rocks are intermediate metavolcanics and minor metasediments to the south of the tonalite stock. Pyrite, chalcopyrite, arsenopyrite, and galena are the sulphide minerals associated with the gold mineralization. Extensive assaying in conjunction with the drilling returned values which are low, typically trace to 0.05 ounces Au per ton with a maximum value of 0.20 ounces per ton. Assays from the drilling program are considerably lower than those reported from the underground workings on the main vein.

Kerr Addision Mines Limited optioned the property from Andowan Mines Limited in 1972 and carried out a restricted sampling program of surface trenches. Six samples were analyzed and returned between trace and 0.04 ounces Au per ton, and had similarly low values for Ag.

In 1979 K. J. McTavish trenched the showing and resampled the property. To date results of this work are not available.

Also in 1979, this property was examined as part of a study of gold mineralization in the area by the Ontario Geological Survey (Wilkinson 1980). The deposit was classified as a strataform type in which the mineralization is restricted to a particular horizon and is associated with chert pods and a stockwork of quartz and quartz-carbonate veins. Assay vaues obtained during Wilkinson's study ranged between nil and 3 g/t (grams per tonne) gold but with typical values of 0.046 g/t (0.001 ounces per ton), and nil to 4 g/t silver with typical values of nil.

Geology

The Mayflower prospect is located in an aureole of silicified and carbonatized metavolcanics adjacent to a small tonalite stock (Figure 16a). The metavolcanics are of intermediate to mafic composition and to the south of the shaft, minor shale and magnetite ironstone are intercalated with the metavolcanics. The rocks have been intruded by a small tonalite stock which outcrops to the west of the shaft and by a satellite stock which is overlain by glacial deposits to the east of the shaft. These two stocks are connected at depth (see Figure 16b) and form a saddle structure. Adjacent to the tonalite contact the metavolcanics are commonly strongly carbonatized, and more locally, they are silicified. The contacts with less altered metavolcanics are gradational. The alteration is associated with an erratic stockwork of quartz and quartz-carbonate veins and minor brecciation. The author's interpretation of the carbonatized and silicified rocks as altered metavolcan-

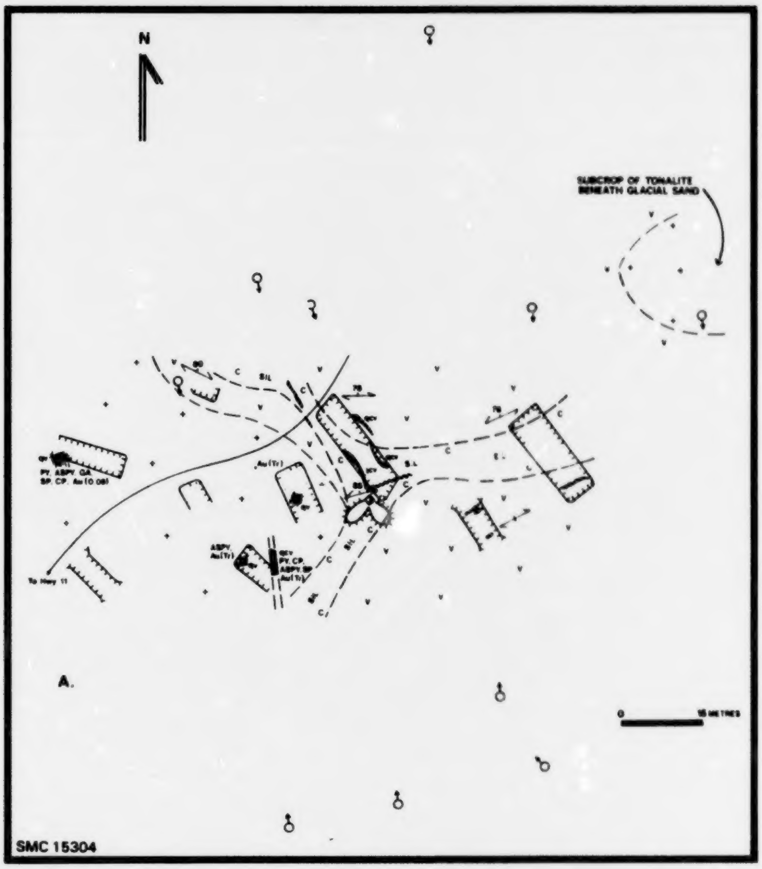

N
SUBCROP OF TONALITE BENEATH GLACIAL SAND
SIL
C
PY, ASPY, GA
SP, CP, Au (0.08)
Au (Tr)
ASPY, Au (Tr)
QV
PY, CP,
ASPY, SP
Au (Tr)
To Hwy 11
A.
0
15 METRES
SMC 15304

Figure 16a. *Geological sketch map of the Mayflower prospect. Modified from Wilkinson (1980).*

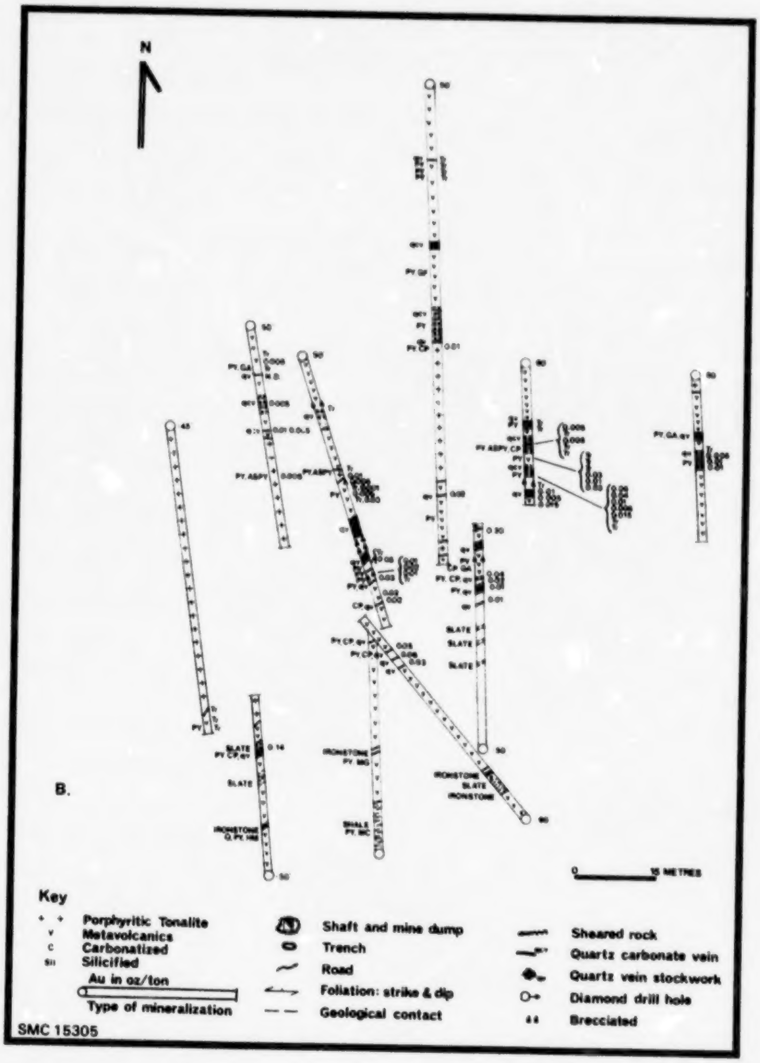

N
B.
0
15 METRES
Key
Porphyritic Tonalite
Metavolcanics
Carbonatized
Silicified
Au in oz/ton
Type of mineralization
Shaft and mine dump
Trench
Road
Foliation: strike & dip
Geological contact
Sheared rock
Quartz carbonate vein
Quartz vein stockwork
Diamond drill hole
Brecciated
SMC 15305

Figure 16b. *Plan of diamond drill intersections, projected vertically, at the Mayflower prospect. The holes, drilled by Freeport Exploration Limited in 1946, show that a saddle structure connecting the two tonalite stocks underlies the carbonatized and mineralized zone.*

ics is different from that of Wilkinson (1980) who interpreted these rocks as metamorphosed primary carbonaceous and chert units. It would appear that the known gold mineralization is erratically distributed in the alteration aureole, and primarily concentrated in the main quartz vein which has been prospected by underground workings.

W.S. MURRAY (MILLS CREEK OCCURRENCE) (8)

Three claims were staked by W.S. Murray in 1980 about 600 m south of the Mills Creek estuary, subsequent to a report on the occurrence by the Regional Geologist (Fenwick *et al.* 1980). This occurrence has been staked a number of times in the past but no record of any exploration work is known to exist.

In 1979 geologists from the Ministry of Natural Resources Regional Geologist's office examined this occurrence and gave the following account (Fenwick *et al.* 1980).

> "The occurrence consists of an extensive brecciated volcanic carbonate unit, randomly intruded by cross-cutting quartz and carbonate veinlets. It is located on the northern portion of the Quetico Fault zone. Both the volcanic carbonate unit and the veinlets contain disseminated pyrite, chalcopyrite and arsenopyrite. The sulphides are more concentrated in the veinlets. This unit is iron-rich and exhibits reddish weathering.
>
> Five grab samples were submitted for assay but the results are not available yet."

The results of these grab samples were subsequently obtained from the Regional Geologist's office and are given in Table 8.

The occurrence is located on the northern side of an outcrop adjacent to a large swamp which is underlain by a major fault.

TABLE 8. ASSAYS OF GRAB SAMPLES FROM MILLS CREEK OCCURRENCE. SAMPLES COLLECTED BY STAFF OF REGIONAL GEOLOGIST'S OFFICE, ONTARIO MINISTRY OF NATURAL RESOURCES, THUNDER BAY.

Au	Ag	Cu	Co	Ni	Pb	Zn
0.02	Tr	-	-	na	na	na
0.01	0.01	-	-	na	na	na
Tr	0.10	50	52	156	38	43
Tr	Tr	240	70	178	26	163
Tr	Tr	50	50	114	15	130
Tr	0.11	-	-	-	-	-

NOTES

Assays by Geoscience Laboratories, Ontario Geological Survey, Toronto. Au and Ag in ounces per ton; other elements in parts per million.

Tr - trace; na - not analysed.

W.S. MURRAY (GEHL LAKE OCCURRENCE) (9)

Two claims were staked by W.S. Murray in 1979, centred on the western end of Gehl Lake. This property has also been staked a number of times in the past but no record of exploration work has been filed for assessment purposes.

In 1979, geologists from the Ministry of Natural Resources Regional Geologist's office examined this occurrence and gave the following report (Fenwick *et al.* 1980).

> "The occurrence consists of a brecciated quartz vein, 75 m long and 1 m wide, within a 2 m wide shear zone in a metasedimentary host rock. It varies in strike from 268 degrees to 30 degrees and dips 70 degrees to vertical. The vein material varies from milky white to sugary white to smokey quartz and contains disseminated pyrite and chalcopyrite. Carbonate locally cuts the vein. Two 2 m by 2 m pits were noted.
>
> Ten grab samples of all rock types present were assayed for Au, Ag and Cu. The highest assay results were 0.01 ounces per ton Au, 0.24 ounces per ton Ag and 0.59 percent Cu."

The complete assay results have been obtained from the Regional Geologist's office and are given in Table 9.

The host metasediments form part of a thin unit of metasediments intercalated with metavolcanics which are located near the Quetico Fault.

TABLE 9. ASSAYS OF GRAB SAMPLES FROM THE GEHL LAKE OCCURRENCE. SAMPLES COLLECTED BY STAFF OF REGIONAL GEOLOGIST'S OFFICE, ONTARIO MINISTRY OF NATURAL RESOURCES, THUNDER BAY.

Rock Type	Mineralization	Au oz/ton	Ag oz/ton	Cu ppm
Quartz vein		Tr	nd	
Quartz vein		Tr	nd	
Quartz vein		Tr	Tr	
Quartz vein & wall rock	pyrite	Tr	Tr	
Quartz vein	chalcopyrite	Tr	0.24	5900
Quartz vein	sulphides	Tr	Tr	505
Quartz vein	sulphides	Tr	Tr	
Quartz vein	sulphides	Tr	Tr	
Quartz vein	barren	Tr	Tr	

NOTES
Assays by Geoscience Laboratories, Ontario Geological Survey, Toronto.
Tr - trace; nd - not detected

E. RIVERS (CEDAR LAKE PROSPECT) (10)

Location and Ownership

A block of 21 claims extends north from Bennett Lake (formerly Cedar Lake) for a distance of approximately 1.6 km. This block of ground was restaked in 1980 and is presently held by E. Rivers.

History of Exploration

The date when this gold occurrence was found is not known, but the earliest records indicate an extensive program was carried out in 1936 by the Cedar Lake Gold Syndicate. The work consisted of extensive trenching (Map 2467, back pocket), assaying, and reconnaissance mapping. It was found that the area was underlain by intercalated metavolcanics and metasediments with concordant porphyry sheets (largely mapped in this survey as tuff and lapilli tuff). The Independence mine is located on the south contact of the northernmost tuff sheet and quartz veins located along this sheared southern contact have been traced some 900 m to the west. Pyrite, chalcopyrite, and galena were found in association with the gold mineralization.

The main work was carried out along an extensively sheared contact between metavolcanics and metasediments. Abundant quartz veins were noted. Sampling in the main trench (No. 1) allegedly produced trace amounts of gold in seven consecutive 0.9 m channel samples across a number of quartz veins at the north end, whereas eleven 0.9 m channel samples over 18 m in the centre of the trench in sheared metavolcanics allegedly contained between $2.10 and $10.15 per ton with an average of $5.20 per ton over 0.9 m (0.10 to 0.49 ounces Au per ton, average 0.25 ounces per ton at 1936 prices). To the south of this trench, 12 channel samples over 25 m of metavolcanics containing some quartz veins were reported to contain between trace and $5.25 per ton with an average of $2.17 per ton over 0.9 m (trace to 0.25 ounces Au per ton, average 0.10 ounces per ton at 1936 prices). The following results were reported for 0.9 m channel samples from other trenches on strike to the east: in trench No. 2, trace, $1.05, and $0.70 per ton; in trench No. 3, $2.10 and $1.75 per ton; in trench No. 4, trace for two samples. Nine 0.9 m channel samples taken from four trenches on an extension of the Independence vein (trench group No. 5) ranged between trace and $5.25 per ton with an average of $2.22 per ton (trace to 0.25 ounces Au per ton, and 0.11 ounces per ton at 1936 prices).

In 1937, Cedar Lake Gold Syndicate put down one diamond drill hole in trench No. 1. Gold values of nil to $7.00 per ton (0.34 ounces Au per ton at 1937 prices) were reported, but typical values were trace to $1.40 per ton (trace to 0.07 ounces Au per ton), considerably less than the trace to 0.49 ounces Au per ton range reported for the channel samples on surface.

Sylvanite Gold Mines Limited resampled the No. 1 trench in 1940. Of six channel samples from the central part of the trench, two reportedly contained trace amounts of gold and four contained $0.80 per ton (0.04 ounces Au per ton at 1940 prices), significantly lower than the assays of Cedar Lake Gold Syndicate's adjacent channel samples. Four channel samples from the south end of the trench were reported to contain $7.20, $2.00, $0.80, and trace per ton (0.35, 0.10, 0.04, and trace ounces Au per ton at 1940 prices), values which are higher than those obtained by the Cedar Lake Gold Syndicate sampling.

In 1958 Jacobus Mining Corporation drilled three diamond drill holes in the vicinity of trench No. 1, presumably to test the previously reported gold mineralization. These holes with a total length of 305 m intersected narrow units of alternating quartzite, greywacke and magnetite ironstone which are intruded by a porphyry. Sulphide mineralization (pyrite, pyrrhotite, chalcopyrite, and sphalerite) was sparsely disseminated throughout the core with localized concentrations of pyrite and pyrrhotite, and veins of pyrrhotite in the banded ironstone. No assay results were reported.

Turbenn Minerals Limited carried out a ground magnetometer survey over the western part of this occurrence in 1960. Two small anomalies less than 250 m in length were detected in the vicinity of trench No. 1.

In 1971, E. Corrigan drilled one diamond drill hole on the shore of Bennett Lake, apparently to test a sulphide occurrence. Metavolcanics with sparsely disseminated pyrite, pyrrhotite and chalcopyrite were intersected. Five assays from the core reportedly returned trace Au, 0.04 to 0.22 percent Cu, and trace to 0.05 percent Ni.

Extensive trenching and stripping was done in 1973 by E. Rivers. Assays of chip samples collected from two of these trenches (No. 8 and 7) are given in Table 10.

TABLE 10. ASSAYS OF CHIP SAMPLES COLLECTED BY E. RIVERS FROM CEDAR LAKE PROSPECT.

Trench	Au oz/ton	Width of sample feet
#8	0.01	10
#8	0.02	20
#7	Tr	50
#7	0.01	20
#7	Tr	13
#7	0.06	27
#7	Tr	10
#7	0.04	20
#7	Tr	20
#7	0.02	12
#7	Tr	18
#7	Tr	13

In 1974, A.C.A. Howe International Limited resampled some of the trenches for International Chemalloy Corporation. Four chip samples from trench No. 8 reportedly contained 0.03, 0.02, trace, and trace ounces Au per ton, and of 17 chip samples from trench No. 7, 14 contained less than 0.01 ounces Au per ton. Three samples, coincident with the 0.06 ounces Au per ton sample obtained by Rivers in 1973, reportedly contained 0.04, 0.02, and 0.02 ounces Au per ton. Six other chip samples from other trenches adjacent to trench No. 7, all reportedly contained less than 0.01 ounces Au per ton.

A ground magnetic and electromagnetic survey was done in 1975 by A.C.A. Howe International Limited which revealed a number of magnetic anomalies and electromagnetic conductors.

A grab sample of oxidized banded ironstone and quartz from trench No. 4, collected by the field party was assayed by the Geoscience Laboratories, Ontario Geological Survey, Toronto, with the following results: 0.03 ounces Au per ton, and trace Ag, As, Mo, Pb, Cu and Ni.

Geology

The geology of the area north of Bennett Lake is complex. Metavolcanics and metasediments are intercalated on a scale of 0.5 m to several hundred metres. Furthermore there is a wide textural and compositional variety in the metavolcanics which are predominantly mafic to intermediate in composition and range from tuff-breccia to pillowed flows to massive amphibolite. Both epiclastic and chemical metasediments occur. The epiclastic metasediments are dominant and range from well sorted arenite to wacke and mudstone. The chemical metasediments consist of thin layers of magnetite and intercalated layers of recrystallized chert and sulphides which have been extensively altered to hematite. Some of the biotite and hornblende gneiss cannot be readily classified as metavolcanics or metasediments. This complexity is thought to be a result of a facies change from a sedimentary to volcanic environment. Furthermore this complex assemblage has been intruded by aplitic and quartz porphyry tonalite dikes and is also transected by several shear zones.

To date the gold mineralization has been found associated with quartz veins in the felsic pyroclastic rocks, in the chemical metasediments, and in shear zones. Quartz veins do not appear to be essential for gold mineralization to occur in the shear zones.

SHELL CANADA RESOURCES LIMITED (11, 12)

Two properties, which are located near Reed Lake and Banning Narrows respectively, were staked in 1979 and are presently owned by Shell Canada Resources Limited. In 1979 Shell Canada carried out reconnaissance exploration over the areas underlain by metavolcanics.

In 1980 the company conducted a ground proton magnetometer survey on the 32-claim eastern property (Banning Narrows). A number of distinct anomalies were delineated in this survey and approximately coincide with banded ironstone. This claim block is underlain by predominantly mafic metavolcanics including tuff-breccia and intercalated bands of felsic metavolcanics, and metasediments. The metasediments are only a minor part of the assemblage and occur in thin bands intercalated with the metavolcanics. The supracrustal rocks have been tightly folded and intruded by small granitic stocks.

The western block of 10 claims (Reed Lake) is transected by the Little Turtle Fault which separates Seine conglomerate to the south from Wabigoon tuff-breccia to the north.

Suggestions for Future Exploration

There are sufficient interesting occurrences in the map-area to justify further exploration for gold. The long neglected Independence mine area is worthy of further study. Trenching and drilling to extend the known dimensions of the quartz vein system; shaft dewatering and underground sampling may all be justified considering the gold values reported by Bow (1899) and given in this report. In addition, because of the similarities among the known deposits, detailed prospecting in the general Independance mine — Cedar Lake prospect area might uncover additional mineralization.

Gold exploration might be directed at locating additional areas of carbonatized and silicified metavolcanic aureoles adjacent to tonalite intrusions, such as occurs at the Mayflower prospect. Tonalite stocks from which the capping of the alteration aureole has not been eroded might provide higher potential for economic mineralization. Two other tonalite stocks were located to the west of the Mayflower prospect and probably more exist.

In the same context geochemical surveys seeking As and Sb anomalies in the metavolcanics may target gold-associated alteration zones (Pirie 1980) for more intense exploration.

The presence in the map-area of felsic tuff-breccia and lapilli tuff, together with electromagnetic conductors located by a recent Ontario Government airborne survey (OGS 1980) suggests that the area may have some potential for base metal mineralization. However, there are no clearly focussed geological targets in view of the absence of coarse, proximal-type felsic pyroclastic rocks and the absence of sulphide occurrences other than those in association with the thin ironstone units and gold occurrences. A reconnaissance program involving ground geophysics to follow up the airborne data, geochemical sampling and detailed geological mapping might be warranted as an initial approach.

REFERENCES

Adams, F.D., Bell, R., Lane, A.C., Leith, C.K., Miller, W.G., and Van Hise, C.R.

1905: Report of the Special Committee for the Lake Superior Region; Journal of Geology, Vol. 13, p.89-104.

Blackburn, C.E.

1973: Geology of the Otukamamoan Lake Area, Districts of Rainy River and Kenora; Ontario Division Mines, Geological Report 109, 42p. Accompanied by Map 2266, scale 1 inch to 1 mile.

Bow, J.A.

1899a: Report on the Mines of Northwest Ontario; Ontario Bureau of Mines, Annual Report for 1899, Vol.8, pt. 1, p.81-83.

1899b: Lower Seine Gold Mines; Ontario Bureau of Mines, Annual Report for 1899, Vol.8, pt. 2, p.263-274.

1901: Mines of Northwest Ontario, Part I; Ontario Bureau of Mines, Annual Report for 1901, Vol.10, p.69-112.

Bruce, E.L.

1925: The Coutchiching Rocks of the Bear's Pass Section, Rainy Lake; Royal Society of Canada, Transactions, Sect.4, Vol.19, p.43-47.

1927: Coutchiching Delta, Geological Society of America Bulletin, Vol.38, p.771-782.

Davies, J.C.

1973: Geology of the Fort Frances Area, District of Rainy River; Ontario Division Mines, Geological Report 107, 35p. Accompanied by Map 2263, scale 1 inch to 1 mile.

Davies, J.C. and Pryslak, A.P.

1967: Kenora-Fort Frances; Ontario Department of Mines, Map 2115, Geological Compilation Series, scale 1 inch to 4 miles.

Fenwick, K.G., Larsen, C.R., Scott, J.F., Mason, M.K., and Schnieders, B.

1980: 1979 Report of North Central Regional Geologist; p.38-61 in Annual Report of the Regional and Resident Geologists, 1979, edited by C.R. Kustra, Ontario Geological Survey, Miscellaneous Paper 91, 143p.

Ferguson, S.A., Groen, H.A. and Haynes, R.

1971: Gold Deposits of Ontario, Part 1, Districts of Algoma, Cochrane, Kenora, Rainy River and Thunder Bay; Ontario Department of Mines and Northern Affairs, Mineral Resources Circular 13.

Fisher, R.V.

1966: Rocks Composed of Volcanic Fragments and their Classification; Earth Science Reviews, Vol.1, p.287-298.

Fumerton, S.L.

1980: Geology of the Righteye Lake Area, District of Rainy River; Ontario Geological Survey Open File Report 5299, 91p.

1982: Redefinition of the Quetico Fault near Atikokan, Ontario; Canadian Journal of Earth Sciences, Vol.19, p.222-224.

Grout, F. F.

1925: Coutchiching Problem; Geological Society of America Bulletin, Vol.36(2), p.351-364.

Harris, F.R.

1974: Geology of the Rainy Lake Area, District of Rainy River, Ontario Division Mines, Geological Report 115, 94p. Accompanied by Maps 2278 and 2279, scale 1 inch to ½ mile.

Hawley, J.E.

1930: Geology of the Sapawe Lake Area with Notes on some Iron and Gold Deposits of Rainy River District; Ontario Department of Mines, Annual Report for 1929, Vol.38, part 6, p.1-56. Accompanied by Map 38E, scale 1 inch to ¾ mile.

Irvine, T.N. and Barager, W.R.A.

1971: A Guide to the Chemical Classification of the Common Volcanic Rocks; Canadian Journal of Earth Sciences, Vol. 8, p.523-548.

Kaye, L.

1967: Geology of Eastern Lac des Mille Lacs Area; Ontario Department of Mines, Geological Report 48, Accompanied by Maps 2104, 2105, scale 1 inch to ½ mile.

CALM LAKE AREA

Lawson, A.C.

1889: Report on the Geology of the Rainy Lake Region; Geological and Natural History Survey of Canada, Annual Report for 1888, Vol.3, pt.1, Rept. F. Accompanied by Map, scale 1 inch to 2 miles.

1912: The Archean Rocks of Rainy Lake; Geological Survey of Canada, Summary Report for 1911, Sessional Paper No.26, p.240-243.

1913: The Archean Geology of Rainy Lake Restudied; Geological Survey of Canada, Memoir 40, 115p. Accompanied by Map 1299, 98a.

Mackasey, W.O., Blackburn C.E., and Trowell, N.F.

1974: A Regional Approach to the Wabigoon-Quetico Belts and its Bearing on Exploration in Northwestern Ontario; Ontario Division Mines, Miscellaneous Paper 58, 30p.

McIlwaine, W.H. and Chorlton, L.B.

1973: East Half of Sapawe Lake Area, District of Rainy River; p.71-74 in Summary of Field Work, 1973 by the Geological Branch, edited by V.G. Milne, D.F. Hewitt and W.J. Wolfe. Ontario Division of Mines, Miscellaneous Paper 56, 202p.

McIlwaine, W.H., and Hillary, E.M.

1974: West Half of Sapawe Lake Area, District of Rainy River; p.65-69 in Summary of Field Work, 1974, by the Geological Branch, edited by V.G. Milne, D.F. Hewitt, and K.D. Card. Ontario Division of Mines, Miscellaneous Paper 59, 206p.

McInnes, W.

1899: On the Geology of the Area Covered by the Seine River and Lake Shebandowan Map Sheets; Geological Survey of Canada, Annual Report for 1897, Vol.11, p.5-54.

Merritt, P.L.

1934: Seine-Coutchiching Problem; Geological Society of America Bulletin, Vol.45, p.333-374.

Moore, E.S.

1940: Geology and Ore Deposits of the Atikokan Area; Ontario Department of Mines, Annual Report for 1939, Vol.48, pt.2, p.1-34.

ODM-GSC

1961a: Beaverhouse Lake Sheet, Rainy River District, Ontario; Ontario Department of Mines - Geological Survey of Canada, Aeromagnetic Map 1141G, scale 1 inch to 1 mile.

1961b: Manion Lake Sheet, Rainy River District Ontario; Ontario Department of Mines - Geological Survey of Canada, Aeromagnetic Map 1142G, scale 1 inch to 1 mile.

OGS

1980: Airborne Electromagnetic and Total Intensity Magnetic Survey, Atikokan-Mine Centre Area, Western Part, District of Rainy River; Ontario Geological Survey, Geophysical/Geochemical Series, Maps 80506, 80507, 80508, 80509, 80510, and 80511, scale 1:20,000. Survey by Questor Surveys Ltd.

OGS-GSC

1980: Regional Lake Sediment and Water Geochemical Reconnaissance Data, Rainy Lake/Quetico Area, Ontario, NTS 52C; Ontario Geological Survey Open File Report 5285, 52p. 16 maps, scale 1:250,000, maps 80-442 to 80-457 inclusive.

Parkinson, R.N.

1962: Operation Overthrust; p.90-101 in Tectonics of the Canadian Shield, Royal Society of Canada, Special Publication No.4.

Pettijohn, F.J.

1937: Early Pre-Cambrian Geology and Correlational Problems of the Northern Subprovince of the Lake Superior Region; Geological Society of America Bulletin, Vol.48(2), p.153-202.

Pirie, J.

1978: Geology of the Crooked Pine Lake area, District of Rainy River; Ontario Geological Survey Report 179, 73p. Accompanied by Map 2405, scale 1:31,680.

1980: Regional Geological Setting of Gold Mineralization in the Red Lake Area, NW Ontario; p.303-358 in Genesis of Archean, Volcanic-Hosted Gold Deposits, edited by R.G. Roberts, Proceedings of Symposium at University of Waterloo, March 1980, Ontario Geological Survey, Open File Report 5293, 387p.

Poulsen, K.H.

1979: Polyphase Deformation of Archean Rocks at Rainy Lake, Ontario; Institute on Lake Superior Geology, 25th Annual Meeting, Duluth, Abstracts, p.32.

Poulsen, K.H., Borradaile, G.J. and Kehlenbeck, M.M
1980: An Inverted Archean Succession at Rainy Lake, Ontario; Canadian Journal of Earth Sciences, Vol. 17, p.1358-1369.

Sage, R.P., Breaks, F.W., Stott, G.M. and McWilliams, G.M.
1974: Operation Ignace-Armstrong, Mine Centre Sheet; Ontario Division of Mines, Preliminary Map P.965, Geological Series, scale 1 inch to 2 miles.

Schwerdtner, W.M., Stone, D., Osadetz, K., Morgan, J., and Stott, G.M.
1979: Granitoid Complexes and the Archean Tectonic Record in the Southern Part of Northwestern Ontario; Canadian Journal of Earth Sciences, Vol.16, p.1965-1977.

Shklanka, R.
1972: Geology of the Steep Rock Lake Area, District of Rainy River; Ontario Department of Mines, Geological Report 93.

Smith, W.H., and McInnes, W.
1897: Seine River Sheet, Thunder Bay and Rainy River Districts, Province of Ontario; Geological Survey of Canada, Map 560, scale 1 inch to 4 miles.

Streckeisen, A.
1976: To Each Plutonic Rock its Proper Name; Earth Science Reviews, Vol.12, p.1-33.

Tanton, T.L.
1926: Recognition of the Coutchiching near Steeprock Lake, Ontario; Royal Society of Canada, Transactions, Section 4, 3rd series, Vol.20 (pt.1), p. 39-49.
1933: Kenora Sheet, Ontario; Geological Survey of Canada, Map 266A, scale 1 inch to 8 miles.

Walker, R.G.
1976: Facies Models; Geoscience Canada, Vol.3.

Wilkinson, S.J.
1980: Gold Deposits of the Atikokan Area, Districts of Rainy River and Kenora; Ontario Geological Survey, Open File Report 5307, 125p.

Wood, John
1980: Epiclastic Sedimentation and Stratigraphy in the North Spirit Lake and Rainy Lake Areas - a Comparison; Precambrian Research, Vol.12, p.227-255.

Wood, J., Dekker, J., Jansen, J.G., Keay, J.P., and Panagapko, D.
1980: Mine Centre Area (Western Half), District of Rainy River; Ontario Geological Survey, Preliminary Map P.2201, Geological Series, scale 1:15,840.

Young, G.M.
1967: Sedimentology of Lower Visean? Rocks in the Western Part of the Ballina and Donegal Synclines, Northwestern Ireland; Unpublished Ph.D. Thesis, University of Glasgow, 204p.

Young, W.L.
1960: Geology of the Bennett-Tanner Area; Ontario Department of Mines, Annual Report for 1960, Vol.69, part 4, accompanied by Map 1960b, scale 1 inch to ½ mile.

Zoltai, S.C.
1965: Surficial Geology, Kenora-Rainy River; Ontario Department of Lands and Forests, Map S165, scale 1 inch to 8 miles.

INDEX

Actinolite
  Biotite gneiss 24
  Diorite-quartz diorite 30
  Diorite-tonalite 32
  Mafic to intermediate metavolcanics 10
  Wacke 24
Agmatitic rock
  Photo 22
Allanite
  Wacke 24
Alteration
  Conglomerate
    Photo 21
  Mafic to intermediate metavolcanics 11
Amphibole
  Diorite-tonalite 32
Amphibolite 7,9,10-11,30
Amphibolite facies metamorphism 42
  Calm Lake metasediments 24
  Mafic to intermediate gneissic rock & amphibolite 10
Amygdules 7
Analyses
  AFM Plot
    Metavolcanics 13
  CaO-MgO-Al_2O_3 plot
    Metavolcanics 13
  Chemical
    Andesite 12
    Basalt 12
    Dacite 12
    Felsic metavolcanics 12
    Hornblende-biotite granoblastic gneiss 12
    Lapilli tuff, felsic 12
    Mafic flows 12
    Mafic metavolcanics 12
    Tonalite 28
    Tuff, felsic 12
    Tuff, mafic 12
    Tuff-breccia, mafic 12
  Modal composition
    Diorite-tonalite stocks 31
    Felsic to intermediate intrusive rocks 31
    Plutonic rocks 26
  Trace element
    Cedar Lake prospect (assay) 61
    Felsic quartz crystal tuff (assay) 51
    Gehl Lake occurrence (assay) 59
    Independence mine (assay) 51,53
    Law occurrence (assay) 49
    Mafic tuff (assay) 49
    Mills Creek occurrence (assay) 58
    Porphyritic tonalite (assay) 53
    Pyritiferous, graphitic metasediments 46
Anatectic melting 23
  Photo 22
Andesite
  Tholeiitic
    Chemical analyses 12
Andowan Mines Ltd. 54,55
  Hidden Treasure 'Mine' 46-47
Animikie Mines Ltd. 46,54
Anorthite
  see: Plagioclase
Antiforms 38-41
  Figure 39
Arenites 19,22,24
  Classification
    Figure 3
  Photo 17
Arsenopyrite
  Gold 45,54,58
Assays
  see: Analyses
Atikokan 34,35
Auger, J.E.V. 47
Augite
  Diorite-quartz diorite 30
  Diorite-tonalite 32
  Mafic to intermediate metavolcanics 10
Aureole
  Tonalite stock
    Gold 45,55,58,62

Banding
  Mudstone 15,19
  Shale & siltstone 19
Banning Lake 20
Banning Narrows 32,35,47,61
Basalt
  Tholeiitic
    Chemical analyses 12
Base metals 45-46,62
Bedding
  Arenite & wacke 22
  see also: Cross bedding; Graded bedding
Bennett Lake *passim*
Biotite
  Biotite gneiss 23
  Diorite-quartz diorite 30
  Diorite-tonalite 32
  Granite 32
  Granodiorite 29
  Hornblende gneiss 25
  Leuco-tonalite 30
  Mafic to intermediate metavolcanics 10,11
  Rims
    Photo 23
  Wacke 24
Blind Pig Bay 22,47

CALM LAKE AREA

- Boudinage
  - Quartz veins
    - Tonalite 27
- Brecciation
  - Migmatitic rock
    - Photo 22
  - Tonalite stock 28
    - Gold 55
  - Volcanic carbonate unit
    - Gold 58
- Brown, R.R. and Assoc. 47

- Calc-alkaline rocks
  - AFM plot 13
  - CaO-MgO-Al_2O_3 plot 13
  - Mafic to intermediate pyroclastic rocks . 11
- Calm Lake metasediments 14,20-25, 38,41,44
  - Photo 21,22,23
  - Tonalite sheets & stocks 27
- Calm Lake Stock 31,32-33,37,38,42,43
  - Modal composition 26
- Canadian Nickel Co. Ltd. 47
- Carbonate
  - Brecciated tonalite stock 28
  - Felsic pyroclastic rocks 14
  - Mafic to intermediate metavolcanics . . . 10
  - Seine River wedge 7
  - Shear zone 49
  - Wacke 15,20
  - see also: Quartz-carbonate veins
- Carbonate rock
  - Mafic to intermediate metavolcanics . . . 11
    - Gold 58
- Cedar Lake 53,59
  - see also: Bennett Lake
- Cedar Lake Gold Synd. 60
- Cedar Lake prospect 26,45,60-62
- Chalcopyrite
  - Gold 45,46,47,49,51,54,55,58,59,60
- Chert 25-26
  - Conglomerate, clasts in 17
    - Photo 18
  - Wacke, clasts in 15
- Chlorite
  - Biotite gneiss 24
  - Diorite-tonalite 32
  - Leuco-tonalite 30
  - Mafic to intermediate metavolcanics . . . 10
  - Seine River wedge 7
    - Mudstone 15
- Clark, R.A. 47
- Cleavage
  - Slate 19
- Cominco Ltd. 47
- Conductors 44
- Conglomerate 5,16,21-22,37
  - Photo 21
  - Polymictic 16-19
    - Photo 17,18
  - Pyrite 45
- Copper
  - Gold 58,60
  - Rusty metasediments 46
- Corrigan, E. 60
- Crayfish Fault 34
- Cross bedding
  - Sandstone 19
- Cummingtonite
  - Diorite-tonalite 32

- Dacite
  - Calc-alkalic
    - Chemical analyses 12
- Dalby, A.E. 49
- Deer Island 22
- Diorite 5,30
  - Conglomerate, clasts in
    - Photo 17
  - Dikes 33
  - Quartz 29,30
  - Stocks 31-32,42
    - Modal compositions 31
- Dovetail Lake Dome 29
- Drag folds 35,38

- Ear Lake 30
- Epidote
  - Biotite gneiss 24
  - Diorite-tonalite 32
  - Granodiorite 29
  - Hornblende gneiss 25
  - Mafic to intermediate metavolcanics . . . 10
  - Wacke 24
- Fault bounded blocks
  - Conglomerate (Seine 'Series') . . 16,20,41
- Faults 34-38,43,44
  - Little Turtle Fault system 37-38
  - Quetico Fault system 34-37
  - see also: Wrench faults; Splay faults; Hinge faults
- Feldspar
  - Arenite 24
  - Biotite gneiss 24
  - Felsic flows 11
  - Felsic pyroclastic rocks 14
  - Granite 32
  - Hillyer Creek Granodiorite Dome 29
  - Little Joe Creek Leuco-Tonalite Dome 30
  - Mafic to intermediate pyroclastic rocks . 10
  - Sandstone-mudstone 19
  - Tonalite 27,32
  - Wacke 15,24
- Fin Bay 47
- Flanders 34,45,46,54
- Flow rocks
  - Mafic
    - AFM plot 13
    - CaO-MgO-Al_2O_3 plot 13

- Flow rocks
  - Felsic . . . 11
  - Mafic . . . 7,10,11
  - Mafic to intermediate . . . 7
    - Debris . . . 8
    - Feldspar-porphyritic . . . 7,10
    - Hornblende-porphyritic . . . 7
    - Pillowed . . . 7
- Folding . . . 38-41
  - Isoclinal . . . 5
  - see: Drag folds; Kink folds
- Foliation
  - Biotite gneiss . . . 15
  - Conglomerate
    - Photo . . . 17
  - Felsic pyroclastic rocks . . . 14
  - Granitoid domes . . . 26
    - Hillyer Creek Granodiorite Dome . . . 29
    - Little Joe Creek Leuco-Tonalite Dome . . . 29
  - Mafic gneissic metavolcanics . . . 9
  - Quetico Subprovince . . . 41
- Freeport Expl. Co. Ltd. . . . 46,55,57

- Gabbro . . . 30
- Galena
  - Gold . . . 45,54,55,59
- Garnet
  - Arenite . . . 24
  - Biotite gneiss . . . 15,24
  - Gneissic mafic to intermediate metavolcanics . . . 9,10
  - Mudstone . . . 19
  - Tonalite . . . 27
- Gehl Lake . . . 11,12,16,19,20,28,35,44,45,58
- Gehl Lake occurrence . . . 58
- Gneiss
  - Biotite
    - Metasediments . . . 15-16,23-24,32
    - Mafic metavolcanics . . . 7,21
  - Hornblende
    - Metasediments . . . 23-24,25,29
    - Mafic metavolcanics . . . 7,21,45
  - Hornblende-biotite granoblastic
    - Chemical analyses . . . 12
- Gneissic rock
  - Little Joe Creek Dome . . . 29
  - Mafic to intermediate metavolcanics . . . 9,10-11
- Gold . . . 44,45,46,47,49-62

- Graded bedding
  - Arenite-wacke . . . 22
  - Wacke-mudstone . . . 15
- Granite . . . 5,27
  - Conglomerate, clasts in . . . 17
    - Photo . . . 18
  - Stocks . . . 32-33,41
- Granitic rocks . . . 26,29
- Granodiorite . . . 5,29
- Graphite
  - Gold . . . 46
  - Metasediments . . . 45
  - Metavolcanics . . . 47
  - Shear zone . . . 44
- Greenschist facies
  - Calm Lake metasediments . . . 24
  - Mafic to intermediate metavolcanics . . . 10
  - Quetico metasediments . . . 16
- Gull Rocks . . . 20,21,22,24,25,27,43,45,46

- Hematite
  - Banded magnetite ironstone . . . 26,46
- Hepburn Bay . . . 21,24,31,32,34,38,43,44
- Herbert, L.V. . . . 47
- Hidden Treasure 'Mine' . . . 46-47
- Hillyer Creek Granodiorite Dome . . . 27,29, 32,38,43,44
  - Modal composition . . . 26
- Hinge fault . . . 38
- Hornblende
  - Biotite gneiss . . . 15
  - Diorite-quartz diorite . . . 30
  - Diorite-tonalite . . . 32
  - Gneissic mafic to intermediate metavolcanics . . . 9,10
  - Hornblende gneiss . . . 23,25
  - Sandstone & mudstone . . . 20
- Howe, A.C.A. International Ltd. . . . 61

- Ilmenite
  - Hornblende gneiss . . . 45
- Independence mine . . . 14,45,49-53,60,62
- Independence Mining & Dev. Co. Ltd. 49,53
- Indiaonta Lake . . . 22,25,45
- International Chemalloy Corp. . . . 61
- Intrusive rocks
  - Felsic . . . 26-30
    - Chemical analyses . . . 28
    - Modal composition figure . . . 26
  - Felsic to intermediate . . . 31-33
    - Modal compositions figure . . . 31
  - Mafic . . . 33
  - Mafic to intermediate . . . 30-31
- Iron . . . 45,46
- Iron silicates
  - Ironstone . . . 46
- Ironstone, banded magnetite . . . 5,25-26, 35,43,44,47,60,61,62
  - Gold . . . 61
  - Iron . . . 46

- Jackfish Lake . . . 20
- Jacobus Mining Corp. . . . 60

- Kennedy, J.A. et al. . . . 49
- Kerr Addison Mines Ltd. . . . 55
- Kink folds . . . 41

- Lapilli tuff, felsic . . . 14,62
  - Chemical analyses . . . 12

Law occurrence 45,47-49
Law Syndicate 47
Lead
  Rusty metasediments 46
Lineaments 41,43,44
  Figure 36
Lithologic units
  Table of 6-7
Little Joe Creek Leuco-Tonalite
  Dome 27,29-30,38,43
  Modal composition 26
Little Joe Lake 43,44
Little Turtle Fault system 5,8,19,34,35,38,41, 42,43,44,46
  Figure 34,36
Little Turtle Lake 37
Long Lake 37,45

MacLean, R.J. et al.
  Independence Mine 49-53
McLeod, H.D. 47
McMillan, W.J. 47
McPherson Lake 7,20,21,25,30,41,43,45
McPherson Lake Stock 30-31,42,43
McTavish, K.J. 46
  Mayflower prospect 54-58
Magnetite
  Banded ironstone 26,46
Marmion-Selwyn Lakes Fault 34
Mayflower Gold Mines Ltd. 54,55
Mayflower prospect 45,46,54-58,62
Metasediments 31,44
  Base metals 46
  Calm Lake metasediments 14,20-25, 38,41,44
    Photo 21,22,23
    Tonalite sheets & stocks 27
  Chemical metasediments 25-26
    Gold 61
  Graphitic 45
    Trace element analyses 46
  Quetico metasediments 14-16,41
  Seine 'Series' metasediments 16-20
    Photo 17,18
Metatexite 24
  Photo 23
Metavolcanics 5-14,31,43,44
  AFM plot 13
  $CaO\text{-}MgO\text{-}Al_2O_3$ plot 13
  Carbonatized-silicified
    Gold 45,55,62
  Chemical analyses 12
  Conglomerate, clasts in 17
    Photo 18
  Felsic 11-14
    Conglomerate clasts 17
    Flows 11
    Petrography 14
    Pyroclastic rocks 11,14
      Gold 61
  Mafic to intermediate 7-11
    Alteration 11
    Amphibolite 9,10-11
    Debris flows 8
    Flows 7,10
    Gneissic 9,10-11
    Petrochemistry 11
    Petrography 10-11
    Photo 8,9
    Pyroclastic rocks 8,10
    Sheared
      Gold 46,47
Microcline
  Leuco-Tonalite 30
  Tonalite 28
Mid Island 23,24,44,45
Migmatitic rock 23-24
  Photo 22
Migmatization 42
Mills Creek 8,14,19,25,37,58
Mills Creek occurrence 58
Mine Centre area 45
Miners Lake 9
Mining & Land Dev. Co. 54
Miranda Creek 9,20,31
Miranda Creek Stock 31-32,42,43,44
  Modal compositions 31
Modred Lake 14
Moneta Porcupine Mines Ltd. 47
Moonshine Lake 47
Mudstones
  Classification
    Figure 3
  Quetico metasediments 5,15
  Seine 'Series' metasediments . . . 16,19-20
Murray, W.S.
  Gehl Lake occurrence 58
  Mills Creek occurrence 58
Muscovite
  Biotite gneiss 24
  Felsic pyroclastic rocks 14
  Granodiorite 29
  Leuco-tonalite 30
  Mafic to intermediate metavolcanics . . . 10
  Wacke 15,24

Nickel
  Gold 61
Niven Creek Stock 31-32,42,43
  Modal compositions 31
Niven Lake 47
Nodular structures
  Conglomerate 21

Perch Lake 20
Phyllosilicates
  Wacke 15,20
Plagioclase
  Diorite-quartz diorite 30
  Diorite-tonalite 32
  Felsic pyroclastic rocks 14

  - Granite 32
  - Granodiorite 29
  - Leuco-tonalite 30
  - Mafic to intermediate metavolcanics 10
  - Mudstone 19,20
  - Tonalite 28
  - Wacke 24
  - see also: Feldspar
- Plutonic rocks 5,41,43
  - Classification system
    - Figure 4
  - Intermediate
    - Modal composition 26
  - see also: Intrusive rocks, felsic
- Preston, W.A. 54
- Price Creek 11,12,19
- Price Lake 16,17,35,38,41
- Pyrite 44,47
  - Base metals 45
  - Conglomerate 45
  - Gold 45,46,47,49,51,54,55,58,59,60,61
  - Ironstone 46
  - Slate 19
- Pyroclastic rocks
  - AFM plot 13
  - CaO-MgO-Al_2O_3 plot 13
  - Felsic 11,14
    - Gold 61
  - Mafic to intermediate 8,10
    - Photo 8,9
- Pyrrhotite
  - Gold 45,47,49,60

- Quartz
  - Arenite 24
  - Biotite gneiss 24
  - Diorite-quartz diorite 30
  - Diorite-tonalite 32
  - Felsic flows 11
  - Gold 49
  - Granite 32
  - Granodiorite 29
  - Leuco-tonalite 29,30
  - Lenticular lenses
    - Granitoid domes 26,29
  - Mafic to intermediate metavolcanics 10
  - Mudstone 15,19
  - Quartz crystal tuff 14
  - Sandstone 19
  - Tonalite 27,28
  - Wacke 15,20,24
- Quartz-carbonate veins
  - Gold 54,55,58
- Quartz diorite
  - see: Diorite
- Quartz-feldspar veins
  - Biotite gneiss 15
  - Hillyer Creek Dome 29
  - Metatexite 24
    - Photo 23
- Quartz veins
  - Brecciated tonalite stock 28
  - Gold 45,46,47,49,51,53, 54,55,58,59,60,62
  - Hillyer Creek Dome 29
- Quetico 35
- Quetico Fault system 5,8,14,16,19,20, 34-37,38,42,43,44,46
  - Figure 34,36
- Quetico metasediments 14-16,35
- Quetico Subprovince 5,14,38,41,43

- Rainy River Dev. Co. of London 46,54
- Reed Lake 62
- Rice Bay 16,41
- Richardson, J.W. 49
- Right Eye Lake 13
- Rivers, E.
  - Cedar Lake prospect 59-61

- Sandstones 5,16,22
  - Classification system
    - Figure 3
  - Seine 'Series' metasediments 19-20
- Saussuritization
  - Plagioclase 10
- Scheelite
  - Gold 45
- Schist
  - Chlorite 11
    - Conglomerate, clasts in 17
- Schistosity
  - Little Turtle Fault system 37
- Seine River 12,25,37,43
- Seine River Fault 34,35
- Seine River Wedge 5,7,8,14,16,20,41,43
  - see also: Seine 'Series' metasediments
- Seine 'Series' metasediments 5,14, 16-20,25,38
  - Photo 17,18
  - see also: Seine River Wedge
- Shale 19-20
- Sheared rock
  - Photo 9
- Shear zones 35,44,49
  - Gold 45,46,58,59,61
- Sheets
  - Tonalite
    - Calm Lake metasediments 27
    - Chemical analyses 28
- Shell Canada Resources Ltd. 61
- Shoal Lake 16
- Siltstone 19-20
- Silver
  - Gold 45,55,58
- Slate 19-20
- Sphalerite
  - Gold 45,54
- Splay faults 35,36,43,44
  - Figure 37
- Steep Rock 'Series' 20

CALM LAKE AREA

- Stocks
  - Felsic to intermediate ... 31-33
    - Modal compositions ... 31
  - Mafic to intermediate
    - McPherson Lake Stock ... 30-31
  - Tonalite
    - Calm Lake metasediments ... 27
    - Chemical analyses ... 28
    - Mafic metavolcanics ... 27-28
- Strangis, M.J. ... 49
- Sturgeon Falls ... 19
- Sturgeon Falls Dam ... 18,19
- Subalkaline rocks
  - Mafic to intermediate metavolcanics ... 11
- Sulphides ... 45,47
  - Gold ... 54,55,60,62
  - Ironstone ... 60,62
  - see also: Arsenopyrite; Chalcopyrite; Galena; Graphite; Ilmenite; Magnetite; Pyrite; Pyrrhotite; Spnalerite
- Sylvanite Gold Mines Ltd. ... 60
- Synclines ... 38,41
  - Figure ... 39

- Tholeiitic rocks
  - AFM plot ... 13
  - CaO-MgO-Al_2O_3 plot ... 13
  - Mafic flows ... 11
- Tonalite ... 5,27-29
  - Biotite
    - Chemical analyses ... 28
  - Leuco ... 5,27,29-30,41
  - Porphyritic ... 5
    - Chemical analyses ... 28
    - Trace element analyses (assays) ... 53
  - Stocks ... 31-32,42,43
    - Gold ... 45,55,62
    - Modal compositions ... 31
- Tuff, felsic ... 14
  - Chemical analyses ... 12
  - Conglomerate, clast in ... 17
- Tuff, mafic
  - Chemical analyses ... 12
  - Gold ... 48
  - Trace element analyses (assays) ... 49
- Tuff, mafic to intermediate
  - Crystal ... 11
- Tuff, quartz & feldspar crystal ... 14
  - Gold ... 53
  - Trace element analyses (assay) ... 51
- Tuff-breccia
  - Felsic ... 63
  - Mafic to intermediate ... 11,37
    - Chemical analyses ... 12
    - Photo ... 8,9
- Turbenn Minerals Ltd. ... 60
- Turbidites
  - Quetico metasediments ... 5,15,16
  - Seine 'Series' metasediments ... 19
- Twin Lakes ... 22,37

- Vesicles ... 8
  - Photo ... 8

- Wabigoon Subprovince ... 5,16,20,35,41,43,45
  - Folding ... 38
    - Figure ... 39
- Wackes
  - Calm Lake metasediments ... 22,24
  - Classification
    - Figure ... 3
  - Quetico metasediments ... 5,15
  - Seine 'Series' metasediments ... 19,20
- Walton, E. ... 49
- Wrench faults ... 35,37,42
- Wright Lake ... 47

- Xenoliths
  - Granitoid domes ... 26
    - Little Joe Creek Dome ... 29
  - McPherson Lake Stock ... 30

- Zinc ... 44
  - Rusty metasediments ... 46
- Zonation
  - Conglomerate
    - Nodular structures ... 21
  - Debris Flow ... 8
  - Feldspar ... 32
  - Hillyer Creek Granodiorite Dome ... 29
  - Hornblende ... 20
  - Plagioclase ... 32

Ministry of
Natural
Resources
Ontario

LEGEND

CENOZOIC[a]

QUATERNARY

RECENT

Organic swamp deposits

PLEISTOCENE

Ground moraine, sand, clay and till.

UNCONFORMITY

EARLY PRECAMBRIAN[b]

MAFIC INTRUSIVE ROCKS

12	*12a Diorite*

INTRUSIVE CONTACT

FELSIC TO INTERMEDIATE INTRUSIVE ROCKS

GRANITE STOCK (CALM LAKE STOCK)

11	11 *Unsubdivided.* 11a *Biotite granite, fine grained.* 11b *Biotite granite, medium to coarse grained.* 11c *Feldspar phenocrysts.* 11d *Fluorite veins.*

DIORITE TO TONALITE STOCKS (NIVEN CREEK AND MIRANDA CREEK STOCKS)

10	10 *Unsubdivided.* 10a *Biotite-hornblende granodiorite, tonalite.* 10b *Hornblende tonalite.* 10c *Hornblende diorite, quartz diorite.* 10d *Diorite.*

INTRUSIVE CONTACT

METAMORPHOSED MAFIC TO INTERMEDIATE INTRUSIVE ROCKS (MCPHERSON LAKE STOCK)

■	9 *Unsubdivided.* 9a *Gabbro.* 9b *Diorite.* 9c *Amphibolite.* 9d *Quartz diorite.* 9e *Leuco-tonalite.*

INTRUSIVE CONTACT

METAMORPHOSED FELSIC INTRUSIVE ROCKS

■	8 *Unsubdivided.* 8a *Biotite tonalite, fine grained.* 8b *Biotite tonalite, medium to coarse grained.* 8c *Porphyritic (quartz phenocrysts).* 8d *Porphyritic (feldspar phenocrysts).*

LITTLE JOE CREEK DOME

8e *Foliated muscovite-chlorite leuco-tonalite.*

HILLYER CREEK DOME

8f *Foliated biotite granite, granodiorite, tonalite.*

INTRUSIVE CONTACT

METASEDIMENTS[c]

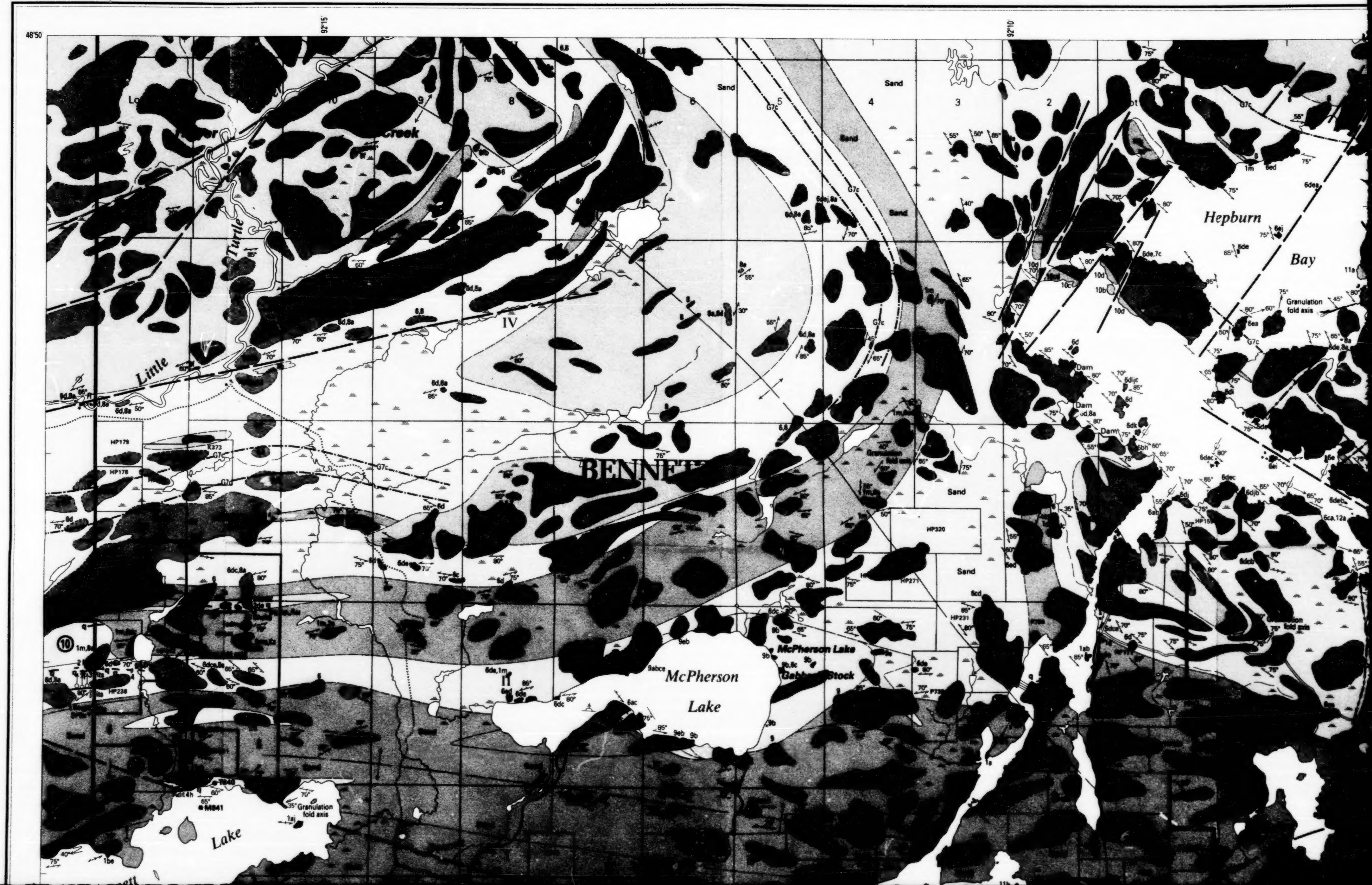
CHEMICAL METASEDIMENTS

7	7a *Chert.* 7b *Iron silicate ironstone.* 7c *Magnetite ironstone.* 7d *Hematite ironstone.*

CLASTIC METASEDIMENTS

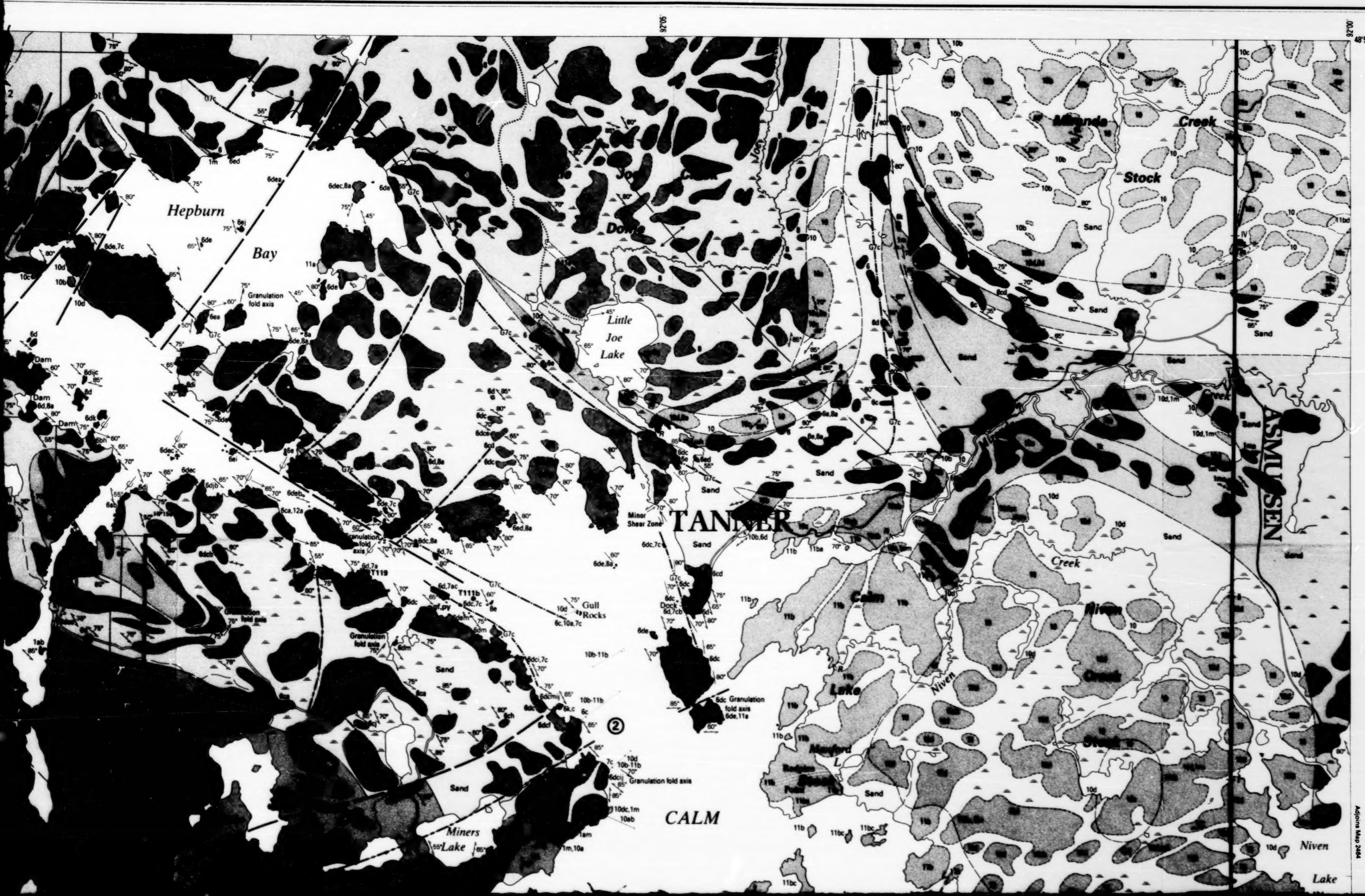
CALM LAKE METASEDIMENTS

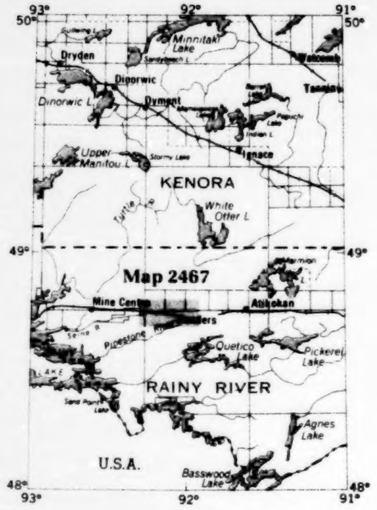
■	6 *Unsubdivided.* 6a *Conglomerate.* 6b *Arenite.* 6c *Wacke.* 6d *Biotite gneiss.* 6e *Hornblende gneiss.*[d] 6f *Muscovitic.* 6g *Actinolitic.*[d]


48°50'
92°15'
92°10'
Turtle
Little
Creek
IV
Sand
BENNETT
Hepburn
Bay
Granulation fold axis
Dam
HP179
HP178
K373
HP320
HP271
HP231
HP238
McPherson Lake
Gabbro Stock
McPherson
Lake
Lake
M841
Granulation fold axis

Ministry of
Natural
Resources
Ontario

Ontario Geological Survey
Map 2467
Calm Lake


92°05'
92°00'
48°50'
Hepburn
Bay
Little
Joe
Lake
Joe
Dome
Stock
Creek
TANNER
ASMUSSEN
Calm
Lake
Niven
Creek
Stock
Gull
Rocks
Minor
Shear Zone
Granulation
fold axis
Dam
Sand
CALM
Miners
Lake
Niven
Lake
Adjoins Map 2464


93°
50°
92°
91°
50°
Dryden
Minnitaki Lake
Dinorwic L.
Dinorwic
Dyment
Upper Manitou L.
KENORA
White Otter L.
49°
Map 2467
49°
Mine Centre
Atikokan
Quetico Lake
Pickerel Lake
RAINY RIVER
Agnes Lake
U.S.A.
Basswood Lake
48°
93°
92°
91°
48°

Scale 1 inch to 50 miles
N.T.S. reference 52C/9,16

SYMBOLS

Glacial striae. Glacial fluting or drumlin.

Esker.

Bedrock; (small outcrop, area of outcrop).

Bedding, horizontal.

70° Bedding, top unknown; (inclined, vertical).

70° 80° Bedding, top indicated by arrow; (inclined, vertical, overturned).

65° 70° Bedding, top (arrow) from grain gradation; (inclined, vertical, overturned).

60° 65° Bedding, top (arrow) from cross bedding; (inclined, vertical, overturned).

Bedding, top (arrow) from relationship of cleavage and bedding; (inclined, overturned).

Lava flow; top (arrow) from pillows shape and packing. Lava flow; top in direction of arrow.

Direction of paleocurrent.

15° Schistosity; (horizontal, inclined, vertical).

75° Gneissosity; (horizontal, inclined, vertical).

80° Foliation; (horizontal, inclined, vertical).

20° Banding; (horizontal, inclined, vertical).

30° Lineation with plunge.

Geological boundary; (observed, position interpreted, deduced from geophysics).

1000γ MA Magnetic contour:value in gammas. Magnetic attraction.

Fault; (observed, assumed). Spot indicates down throw side, arrows indicate horizontal movement.

Lineament.

70° Jointing; (horizontal, inclined,

	9d	Quartz diorite
	9e	Leuco-tonalite.

INTRUSIVE CONTACT

METAMORPHOSED FELSIC INTRUSIVE ROCKS

▨	8	Unsubdivided
	8a	Biotite tonalite, fine grained.
	8b	Biotite tonalite, medium to coarse grained.
	8c	Porphyritic (quartz phenocrysts).
	8d	Porphyritic (feldspar phenocrysts).

LITTLE JOE CREEK DOME

8e	Foliated muscovite-chlorite leuco-tonalite.

HILLYER CREEK DOME

8f	Foliated biotite granite, granodiorite, tonalite.

INTRUSIVE CONTACT

METASEDIMENTS[c]

CHEMICAL METASEDIMENTS

7 ▨	7a	Chert.
	7b	Iron silicate ironstone.
	7c	Magnetite ironstone.
	7d	Hematite ironstone.

CLASTIC METASEDIMENTS

CALM LAKE METASEDIMENTS

▨	6	Unsubdivided.
	6a	Conglomerate.
	6b	Arenite.
	6c	Wacke.
	6d	Biotite gneiss.
	6e	Hornblende gneiss.[d]
	6f	Muscovitic.
	6g	Actinolitic.[d]
	6h	Chloritic.
	6i	Garnetiferous.
	6j	Hornblende porphyroblastic.[d]
	6k	Quartz, feldspar, and muscovite nodules.
	6m	Metatexite.

SEINE METASEDIMENTS

POLYMICTIC CONGLOMERATE

▨	5	Unsubdivided.
	5a	Clast-supported conglomerate.
	5b	Matrix-supported conglomerate.
	5c	Boulder to granule clasts.
	5d	Pebble to granule clasts.
	5e	Granitoid clasts dominant.
	5f	Volcanic clasts dominant.
	5g	Schistose matrix.

SANDSTONE AND MUDSTONE

▨	4	Unsubdivided.
	4a	Feldspathic arenite.
	4b	Lithic arenite.
	4c	Wacke.
	4d	Siltstone, shale.
	4e	Slate.
	4f	Plagioclase-megacrystic rocks.
	4g	Garnetiferous.
	4h	Tuffaceous rocks.

QUETICO METASEDIMENTS

▨	3	Unsubdivided.
	3a	Wacke, mudstone.
	3b	Biotite phyllite, schist.
	3c	Biotite gneiss.
	3d	Amphibolitic.

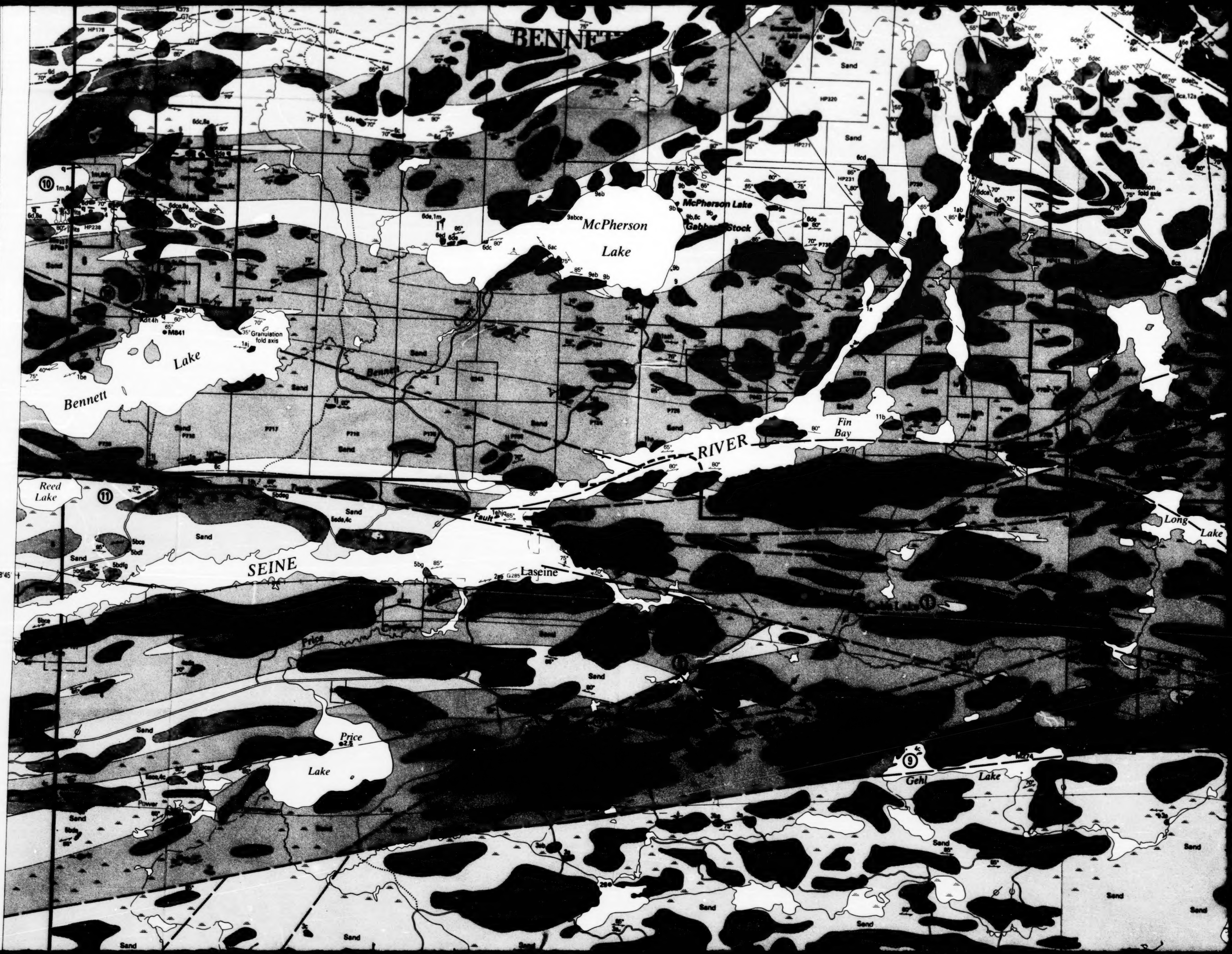
METAVOLCANICS[c]

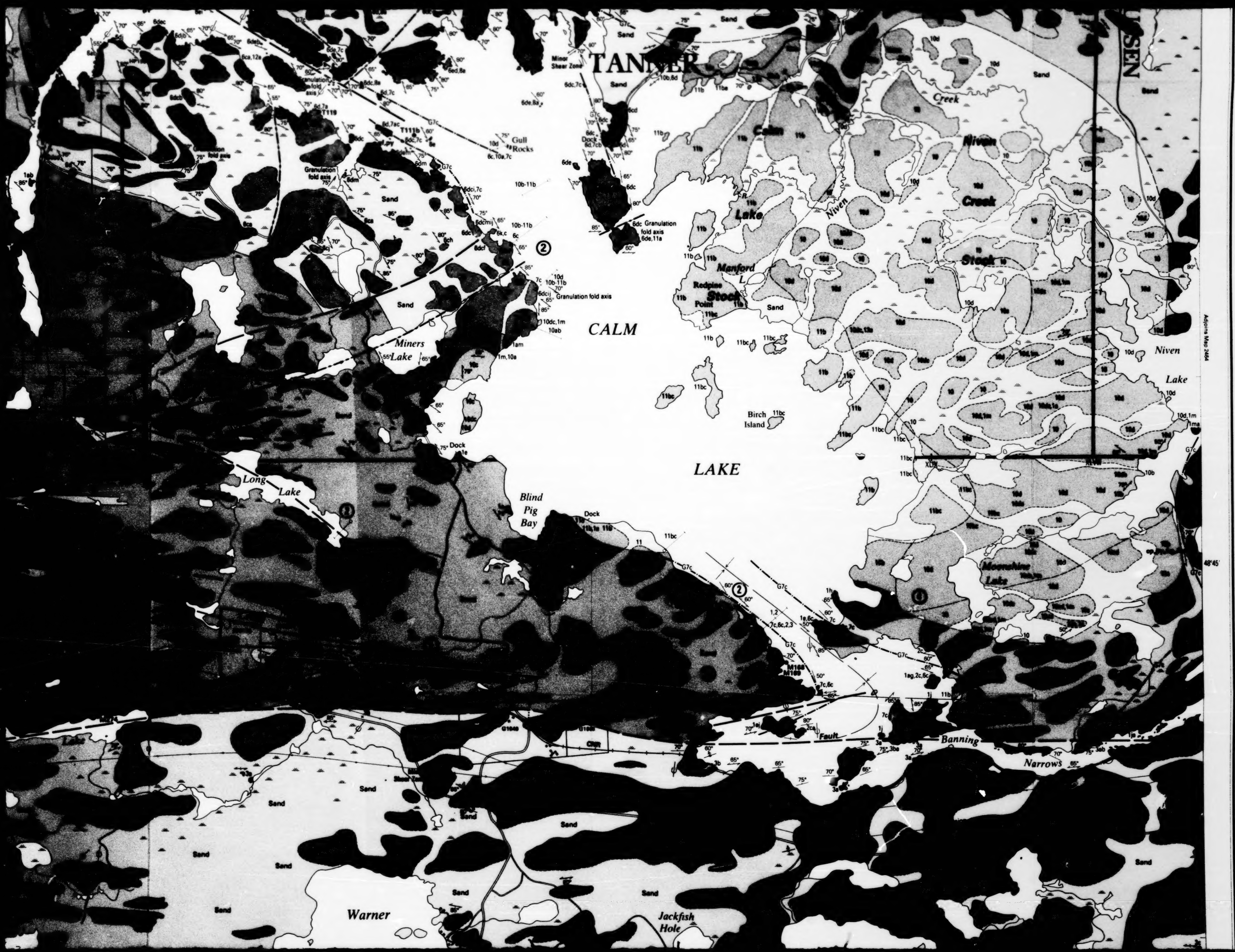
FELSIC METAVOLCANICS

▨	2	Unsubdivided.
	2a	Unsubdivided flows.
	2b	Porphyritic flows (quartz).
	2c	Tuff.
	2d	Lapilli-tuff.
	2e	Sericite phyllite.

MAFIC TO INTERMEDIATE METAVOLCANICS

▨	1	Unsubdivided.
	1a	Unsubdivided flows.[c]
	1b	Pillowed flows.
	1c	Porphyritic flows (feldspar).[c]
	1d	Coarse- to medium-grained flows.
	1e	Tuff.
	1g	Lapilli-tuff.
	1h	Tuff-breccia.
	1i	Heterolithic debris flow.
	1j	Chlorite phyllite, schist.
	1k	Amphibolite.[d, e]
	1m	Hornblende-biotite granoblastic, massive and gneissic rocks.
	1n	Hornblende-porphyroblastic




TANNER
CALM
LAKE
Minor Shear Zone
Gull Rocks
Granulation fold axis
Miners Lake
Long Lake
Blind Pig Bay
Dock
Calm
Lake
Creek
Niven
Niven
Creek
Stock
Manford L
Redpine Point
Stock
Birch Island
Niven
Lake
Moonshine Lake
Fault
Banning
Narrows
Warner
Jackfish Hole
Sand
48°45'
Adjoins Map 2464

ation; (inclined, vertical, overturned).

Bedding, top (arrow) from cross bedding; (inclined, vertical, overturned).

Bedding, top (arrow) from relationship of cleavage and bedding; (inclined, overturned).

Lava flow; top (arrow) from pillows shape and packing. Lava flow; top in direction of arrow.

Direction of paleocurrent.

Schistosity; (horizontal, inclined, vertical).

Gneissosity; (horizontal, inclined, vertical).

Foliation; (horizontal, inclined, vertical).

Banding; (horizontal, inclined, vertical).

Lineation with plunge.

Geological boundary; (observed, position interpreted, deduced from geophysics).

Magnetic contour value in gammas. Magnetic attraction.

Fault; (observed, assumed). Spot indicates down throw side, arrows indicate horizontal movement.

Lineament.

Jointing; (horizontal, inclined, vertical).

Drag folds with plunge.

Antiform, synform, with plunge

Drill hole; (vertical, inclined, projected vertically, projected up dip). Overburden shown.

Location of sample.

Vein, vein network. Width in inches, feet or metres.

Radioactivity.

Swamp.

Motor road. Provincial highway number encircled where applicable.

Other road.
Trail, portage, winter road.

International or Provincial boundary.

County, District, Regional or District Municipal Boundary, with mile post.

Municipal Boundary, (City, Town, Improvement District, Incorporated Township), with milepost.

Township, Indian Reserve, Meridian, Base Line, Provincial Park, with milepost, (surveyed, unsurveyed).

Mining property, surveyed. Mineral deposit or mining property, unsurveyed.

Surveyed line.
Unsurveyed line.

All boundary and survey lines are approximate position only.

Some symbols may not occur on this map.

SOURCES OF INFORMATION

Geology by S.L. Fumerton, E.L. Bumgarner, and assistants, Ontario Geological Survey, 1980. Geology is not tied to surveyed lines.

Regional Geologist's Files, Ministry of Natural Resources, Kenora.

6f Muscovitic.
6g Actinolitic.[d]
6h Chloritic.
6i Garnetiferous.
6j Hornblende porphyroblastic.[d]
6k Quartz, feldspar, and muscovite nodules.
6m Metatexite.

SEINE METASEDIMENTS

POLYMICTIC CONGLOMERATE

▨
5 Unsubdivided.
5a Clast-supported conglomerate.
5b Matrix-supported conglomerate.
5c Boulder to granule clasts.
5d Pebble to granule clasts.
5e Granitoid clasts dominant.
5f Volcanic clasts dominant.
5g Schistose matrix.

SANDSTONE AND MUDSTONE

▨
4 Unsubdivided.
4a Feldspathic arenite.
4b Lithic arenite.
4c Wacke.
4d Siltstone, shale.
4e Slate.
4f Plagioclase-megacrystic rocks.
4g Garnetiferous.
4h Tuffaceous rocks.

QUETICO METASEDIMENTS

▨
3 Unsubdivided.
3a Wacke, mudstone.
3b Biotite phyllite, schist.
3c Biotite gneiss.
3d Amphibolitic.

METAVOLCANICS[c]

FELSIC METAVOLCANICS

▨
2 Unsubdivided.
2a Unsubdivided flows.
2b Porphyritic flows (quartz).
2c Tuff.
2d Lapilli-tuff.
2e Sericite phyllite.

MAFIC TO INTERMEDIATE METAVOLCANICS

▨
1 Unsubdivided.
1a Unsubdivided flows.[c]
1b Pillowed flows.
1c Porphyritic flows (feldspar).[c]
1d Coarse- to medium-grained flows.
1e Tuff.
1g Lapilli-tuff.
1h Tuff-breccia.
1i Heterolithic debris flow.
1j Chlorite phyllite, schist.
1k Amphibolite.[d, e]
1m Hornblende-biotite granoblastic, massive and gneissic rocks.
1n Hornblende-porphyroblastic rocks.
1p Garnetiferous rocks.
1q Carbonatized rocks.
1r Feldspar-porphyroblastic rocks.
1s Silicified rocks.

Ag	*Silver.*	**il**	*Ilmenite.*
asp	*Arsenopyrite.*	**py**	*Pyrite.*
Au	*Gold.*	**sp**	*Sphalerite.*
cp	*Chalcopyrite.*	**q**	*Quartz.*
gf	*Graphite.*	**Zn**	*Zinc.*
gn	*Galena.*		

---

[a] *Unconsolidated deposits. Cenozoic deposits are represented by the lighter coloured and uncoloured parts of the map.*

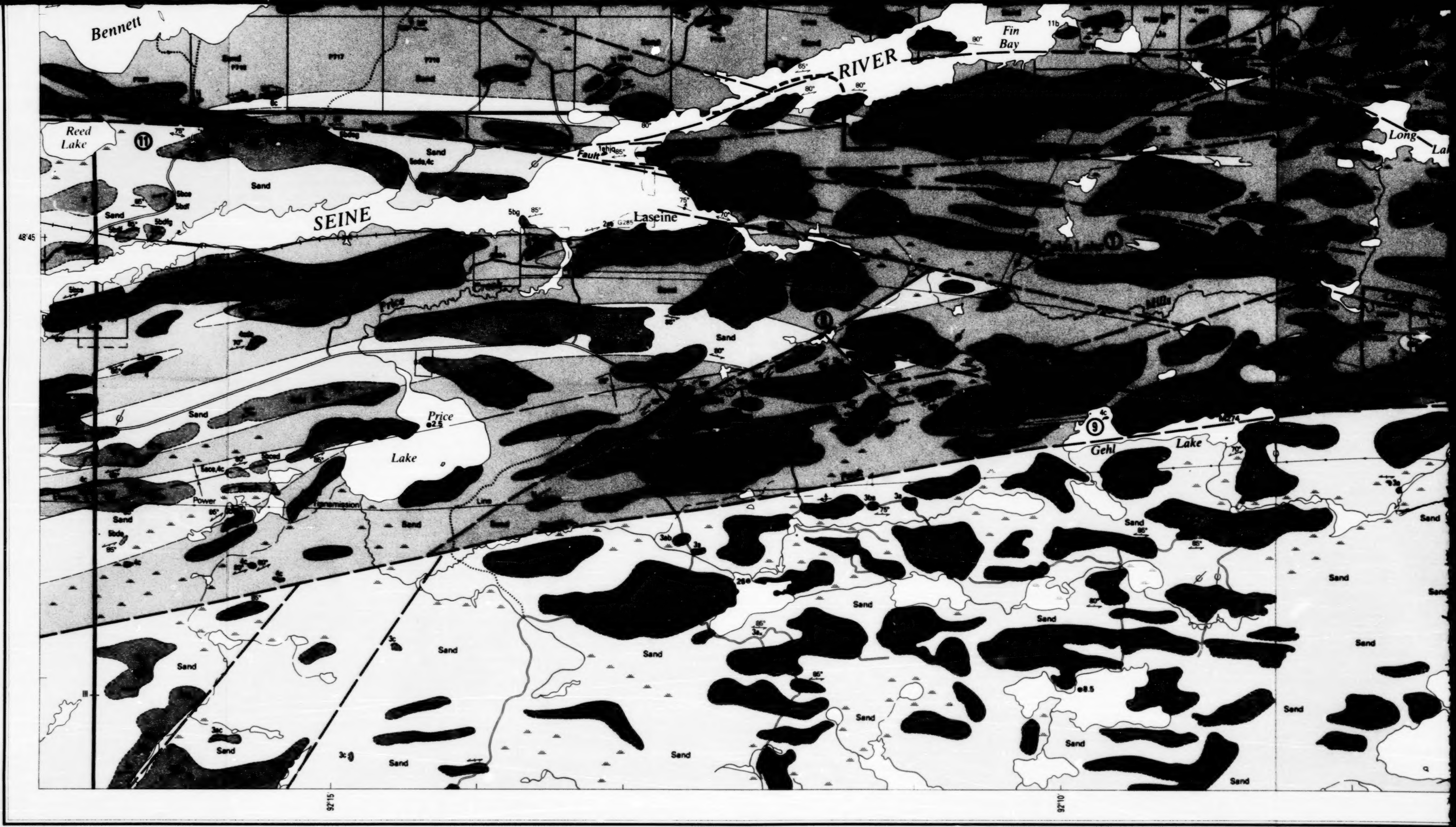
[b] *Bedrock geology. Outcrops and inferred extensions of each rock map unit are shown respectively in deep and light tones of the same colour. Where in places a formation is too narrow to show colour and must be represented in black, a short black bar appears in the appropriate legend block.*

[c] *Rocks in these groups are subdivided lithologically and order does not imply an age relationship.*

[d] *In the absence of primary textures differentiation between hornblendic metasediments and mafic metavolcanics is not always possible.*

[e] *Some of these may be mafic intrusive rocks.*

[f] *The letter "G" preceding a rock unit number, for example "G7c" indicates interpretation from geophysical data in drift covered areas.*



Published 1984

PROPERTIES, MINERAL DEPOSITS

1. Andowan Mines Ltd. [1946]
2. Brown, R.R. & Associates [1954]
3. Canadian Nickel Co. Ltd. [1976]
4. Clark, R.A.
5. Law occurrence.
6. MacLean, R.J. el al. (Independence mine)
7. McTavish, K.J. (Mayflower prospect)
8. Murray, W.S. (Mills Creek occurrence)
9. Murray, W.S. (Gehl Lake occurrence)
10. Rivers, E. (Cedar Lake occurrence)
11. Shell Canada Resources Ltd.
12. Shell Canada Resources Ltd.

Information current to December 31st 1980. Former properties on ground now open for staking are only shown if exploration data is available — a date in square brackets indicates last year of exploration activity. For further information see report.

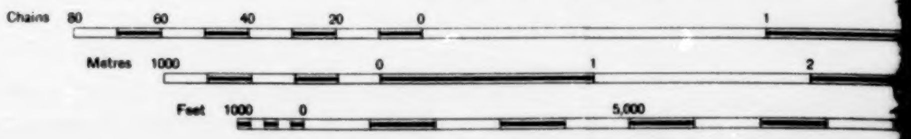
Ontario Geological Survey

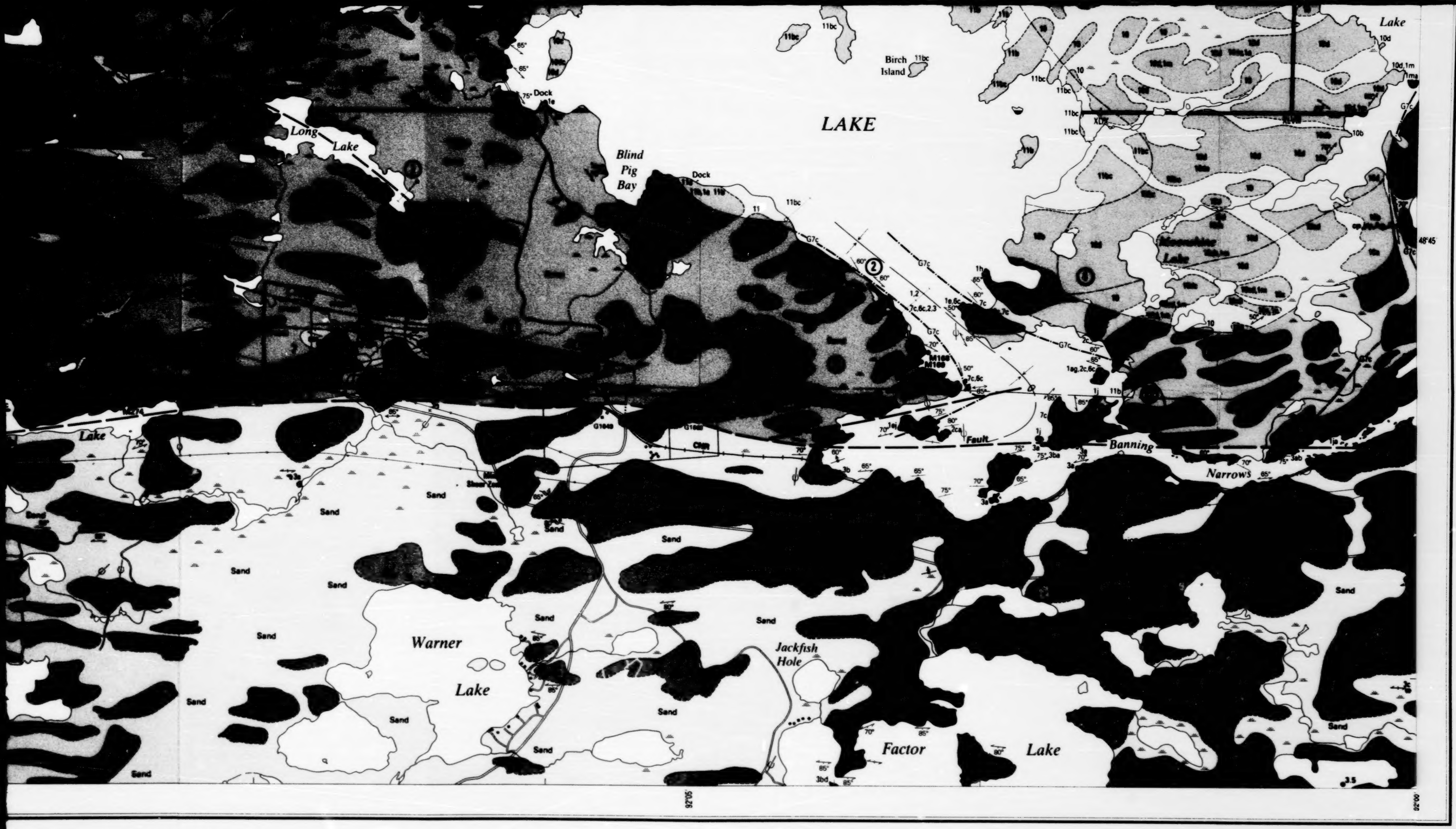
Map 2467

CALM LAKE

RAINY RIVER DISTRICT

Scale 1:31,680 or 1 Inch to ½ Mile





70°	Jointing; (horizontal, inclined, vertical).
80° 80°	Drag folds with plunge.
70° 70°	Antiform, synform, with plunge
DH OV 120'	Drill hole; (vertical, inclined, projected vertically, projected up dip). Overburden shown.
●3	Location of sample.
	Vein, vein network. Width in inches, feet or metres.
RA	Radioactivity.
	Swamp.
540	Motor road. Provincial highway number encircled where applicable.
	Other road. Trail, portage, winter road.
	International or Provincial boundary.
VI	County, District, Regional or District Municipal Boundary, with mile post.
VI	Municipal Boundary, (City, Town, Improvement District, Incorporated Township), with milepost.
VI	Township, Indian Reserve, Meridian, Base Line, Provincial Park, with milepost, (surveyed, unsurveyed).
2 ①	Mining property, surveyed. Mineral deposit or mining property, unsurveyed.
	Surveyed line. Unsurveyed line.

All boundary and survey lines are approximate position only.

Some symbols may not occur on this map.

SOURCES OF INFORMATION

Geology by S.L. Fumerton, E.L. Bumgarner, and assistants, Ontario Geological Survey, 1980. Geology is not tied to surveyed lines.

Regional Geologist's Files, Ministry of Natural Resources, Kenora.

Geological Survey of Canada, Map 266A, 2nd edition, Kenora sheet.

Ontario Department of Mines:
Map 2115, Kenora — Fort Frances, scale 1 inch to 4 miles.
Map 1960b, Bennett-Tanner area, scale 1 inch to ½ mile.

Preliminary Map, Ontario Geological Survey:
P 2405 (rev), Calm Lake Area, scale 1:15,840.

Aeromagnetic Maps (OGS-GSC) 1141G, 1142G.
Airborne electromagnetic and total intensity magnetic survey (OGS-GSC), Maps 80506-80511 incl., scale 1:20,000.
Lake sediment and water geochemical reconnaissance (OGS-GSC), Open File.

Open-File report 5285, Maps 80442-80457 incl., scale 1:250,000.

Cartography by M.G. Sefton and assistants, Surveys and Mapping Branch, 1983.

Basemap derived from maps of the Forest Resources Inventory, Surveys and Mapping Branch, with additional information by S.L. Fumerton.

Magnetic declination in the area was approximately 3° East, 1980.

Parts of this publication may be quoted if credit is given. It is recommended that reference to this map be made in the following form:

Fumerton, S.L.
1984: Calm Lake Area, Rainy River District; Ontario Geological Survey, Map 2467, Precambrian Geology Series, scale 1:31,680, geology 1980.

NOTES

**Sample locations in lakes refer to concentration of As (in ppm) in lake bottom sediments. All plotted points are higher than the 95 percentile.*

Sample location numbers prefixed with the letter "T" indicates trace element analyses.

Sample location numbers prefixed with the letter "M" indicates major element analyses.

Ontario Geological Survey

Map 2467

CALM LAKE

RAINY RIVER DISTRICT

Scale 1:31,680 or 1 Inch to ½ Mile